UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Washington, D. C. 20250

March 10, 1964

ECONOMICS GUIDE

NOTICE 2

Attached is a revised copy of the Economics Guide for Watershed Protection and Flood Prevention. Watersheds Memorandum SCS-35, dated December 8, 1958, is canceled.

This revision incorporates a number of changes brought about by amendments to Public Law 566, the issuance of "Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources", (Senate Document 97), improved procedures developed by Service personnel and others, and new administrative and policy requirements.

These changes have made it desirable to add several chapters dealing with municipal and industrial water supply; recreation, fish and wildlife development; secondary benefits; redevelopment benefits; land, easements, and rights-of-way; and short cuts in evaluation procedures.

Appendix B, "Agricultural Price and Cost Projections", formerly in the Economics Guide is out of print and will not be reproduced. However, any available copies should be saved and used in computing benefits and deferred or continuing costs in accordance with Paragraph 1131.22 of the Watershed Protection Handbook.

Attachment

D. A. Williams

Administrator

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ECONOMICS GUIDE
FOR
WATERSHED PROTECTION AND FLOOD PREVENTION

INTRODUCTION

The purpose of this Economics Guide is to provide guidance in the use of acceptable economic evaluation procedures for evaluating watershed projects. These include projects developed under the authority of the Watershed Protection and Flood Prevention Act (P. L. 566 as amended), as well as the eleven authorized Flood Prevention watersheds.

The evaluation methods, procedures, and examples outlined in this Guide have been designed within the framework of existing statutory and policy requirements. Their use will tend to assure comparability of results and will facilitate review of watershed work plans.

Since watersheds differ in physical and economic characteristics and also vary in the amount and kind of basic data available, no single procedure can be used in every watershed. Alternative procedures, that are consistent with the basic principles and concepts set forth in this Guide, may be used where necessary to better fit the varied conditions that are found throughout the United States.

Material in the Guide is based on the contributions of many persons in the Soil Conservation Service, Economic Research Service and Forest Service and all contributions are gratefully acknowledged. The Soil Conservation Service, however, accepts full responsibility for all material the Guide contains.

Although this Guide is primarily for the use of Soil Conservation Service technicians concerned with formulation and evaluation of watershed projects, it is hoped that it will be useful to others engaged in water resource planning. Users are encouraged to submit comments and suggestions for improvements to the Watershed Planning Division, Soil Conservation Service, Washington, D. C. 20250.

CHAPTER 1

ECONOMIC APPRAISALS - USES, FRAMEWORK AND STANDARDS

This chapter deals primarily with the application of basic economic theory in the appraisal of watershed projects. The first section deals with the uses of economic appraisals. The second discusses the appraisal framework and standards.

I. USES OF ECONOMIC APPRAISALS

The primary purpose of benefit-cost analysis is to provide a basis for determining if a proposed project is economically justified. In addition such analyses should also (a) establish the need for a project, (b) provide guidance for project formulation, and (c) measure the relative economic desirability of different measures and groups of measures to meet agreed-upon project objectives. The economic analysis may also be helpful as a basis for the allocation of costs among purposes and for assessing cost to beneficiaries.

A. Need for Improvement Measures

The first step in the development of a watershed work plan is to identify and measure the water related problems of the watershed. This will include consideration of the following: (1) the severity of erosion losses, (2) the losses resulting from sedimentation, (3) the extent and severity of floodwater damage, (4) the restriction imposed upon the use of the land by poor drainage, (5) the need for, and problems associated with, irrigation in areas or under conditions where required to realize full economic agricultural potential of the lands, (6) the restriction imposed upon the use of land by frequent flooding, and (7) the need for other agricultural water-management measures, municipal water supply, recreational and fish and wildlife development. Each of the above determinations, to be of greatest usefulness, should be expressed in economic terms. Such evaluations, when compared with costs on a standardized basis provide a basis for: (a) determining the objectives for each of the purposes included in a project, (b) estimates of the types and amount of watershed improvement measures to meet these needs and objectives, and (c) determining the economic justification for the project.

B. Guidance for Project Formulation

Once the watershed problems have been determined, the next step is reaching tentative agreement with the sponsors on project objectives. Then the types of measures must be selected which will alleviate the problems and meet the watershed needs effectively. Although economic consideration must be blended with other considerations such as policy, engineering, institutional, legal and local desires, economic principles are basic in formulating a project. Economic analysis will point to types and intensity of development needed and thereby aid in determining the appropriate level of project objectives. Analysis of trends and potentialities may emphasize the need to plan the project to meet future needs that otherwise would not be apparent.

While achievement of equi-marginal returns in the development of all watersheds may be an unobtainable goal, project formulation in accordance with economic principles will be a step toward that goal.

Uses of economics in project formulation are described further in Chapter 2.

C. Relative Economic Desirability

A ratio of benefits to costs of greater than one to one usually is regarded as an indication that the proposed work is economically desirable. This assumes, of course, that adequate financial and other resources (both Federal and non-Federal) are available. Because this may not hold in each situation, an economic analysis should be made for each of several alternative systems of interrelated measures which are most likely to meet project objectives. The system which provides the greatest economic efficiency and which has the greatest possibility of installation should be selected. To facilitate construction and assure that any measures installed will provide benefits at least equal to their costs, benefits which will accrue to individual measures or groups of measures within a system should be identified. This requires that a number of separate evaluations be made in a given watershed, including those for subdivisions of the measures and subdivisions of the watersheds. The physical interdependence of many measures, however, reduces the number of possible seperate appraisals.

D. Guides for Financing

Authorized purposes may be included in a watershed project only if they are economically justified. Careful economic analysis is needed to make sure that no purposes are included that lack economic justification and hence would constitute an inequitable financial burden upon some of the interested participants in the project. This analysis may serve the added purpose of aiding the local sponsoring organization in its financing and assessing problem by indicating the kind of benefits and the broad groups of beneficiaries of the project.

II. APPRAISAL FRAMEWORK AND STANDARDS

The primary function of an evaluation is to provide assurance that effective use can be made of the resources required by proposed watershed projects. To allow necessary comparisons, project evaluations need to be made in accordance with a set of uniform concepts, principles and standards. A set of guides of this kind form the conceptual framework and the analytical apparatus for making an evaluation analysis. The purpose of this section is to review the basic assumptions and principles that underlie the benefit-cost analysis and to indicate general standards and criteria considered appropriate for their application. Aspects covered include principles, concepts and basic assumptions; pricing of project products and services; interest and discount rates and the evaluation period.

A. Basic Principles, Concepts and Assumptions

Watershed development involves the production, conservation, and use of economic goods and services related to land and water. Economic goods and services encompass all objects and services that are limited in supply and have the power of satisfying wants. The basic objective in economic evaluation is to compare the value of the goods and services produced or conserved with that of the costs incurred, after full account is taken of all project effects. For comparable results, it is necessary that uniform standards be used for pricing project goods and services; effects be evaluated from a similar viewpoint; an appropriate basis be used for determining the effects that may be attributed to a project; and consistent assumptions regarding the general economic setting be used.

1. Expression in monetary terms

Beneficial and detrimental effects arise initially in many physical forms, accrue at different times, continue for varying periods, and arise under a variety of circumstances that influence the probability of their occurrence.

Monetary estimates constitute the most practical means of expressing diverse physical effects in comparable terms. Dollars provide a measure of the relative values of different types of effects at the time of their occurrence. Prices provide a system that may be used to convert various and sundry physical effects to a common value. In a market economy, the price system becomes the principal device for bringing about a balanced allocation of resources among competing uses. Prices operate to limit the use of scarce resources and services to meeting needs in accordance with the market rating of their importance. Most watershed projects involve the production, conservation, or use of goods and services that reasonably may be evaluated in terms of market prices.

However, it must be recognized that the values attached to goods and services by the market may not always accurately reflect values from a public viewpoint. This is due in part to the existance of imperfect markets and the influence of such factors as subsidies, tariffs, price supports and surplus commodities. Also, the market measures only the value of marginal units, rather than the total value of the segment subject to change. While it is extremely difficult to give precise quantative expression to certain of these considerations, the general principle that project services or products have value only to the extent that they are needed is inherent in any economic evaluation. Despite limitations of the market as a measure of public values, there is no other suitable framework for evaluating in comparable terms the effects of watershed or other types of projects. Accordingly, market prices are considered the essential starting point for an economic analysis.

To the extent feasible, project effects which are ordinarily evaluated incompletely or not at all in actual market exchange may be given a derived or estimated monetary value. Types of benefits and costs that

cannot be covered by actual or derived market prices still warrant consideration. Intangibles not susceptible of monetary measurement need to be weighed and described in a way that indicates their importance and influence on project formulation and evaluation.

2. Applicable Viewpoint

The viewpoint from which the analysis is made must be consistent for the particular purposes to be served by the analysis. The appropriate viewpoint for the evaluation of projects involving substantial Federal investments is that of a comprehensive National or public viewpoint. Primary emphasis in this viewpoint is placed on taking full account of all significant beneficial and adverse effects. The adequacy of the results obtained depends to a considerable extent on how completely measurement from a comprehensive public viewpoint can be realized; that is, how fully all effects on individuals and the public as a whole can be traced and evaluated in comparable terms. The sum of beneficial or adverse project effects accruing to individuals is likely to fall somewhat short of full coverage from a public viewpoint. Types of beneficial or adverse effects that accrue to the public as a whole may not be considered fully in the value judgements of individuals or local interests. Examples include the value of resource conservation to future generations; effects on health, welfare and National security; and various other effects that are widely dispersed or not directly apparent to those eventually effected.

Application of a comprehensive public viewpoint often requires making a reasonably sharp distinction between economic feasibility on the one hand, and cost-sharing and reimbursement considerations on the other. The viewpoints involved are basically different. In an evaluation from a public viewpoint, the effects properly subject to consideration include various types of offsets that arise in other localities or geographic areas. For cost-sharing, the appropriate viewpoint is usually local in nature and little attention needs to be given offsetting effects outside the area of project influence. In an evaluation from a local viewpoint, the benefit basis for cost-sharing might differ from that available for justifying a project from a National or public viewpoint. Secondary benefits from an area or local viewpoint are likely to be more substantial than from a National viewpoint.

The applicable viewpoint also has a bearing on the standards selected to measure values. The standards for evaluation may differ from those considered appropriate for reimbursement. For example, where cost-sharing involves entering into contractual obligations expressed in dollar terms, price fluctuations and trends become much more significant than in an evaluation from a public viewpoint, where the emphasis is on "real" value relationships. While the procedures and standards applied for evaluation should reflect an overall public or National viewpoint, supplemental analyses based on local and regional viewpoints are needed where pertinent for cost-sharing purposes.

3. Least costly alternatives

Within the limits set by legislation, policy or other constraints, any project or segment selected for installation must satisfy the requirement that it not be more costly than any reasonable alternative means of accomplishing the particular objective contemplated.

No purpose should be recommended if a less costly means of accomplishing essentially the same purpose would thereby be displaced or economically precluded from development as a result of the project.

All practical alternative possibilities within the scope of watershed program activities should be taken into account. In practice, alternatives subject to consideration are likely to be limited by budgetary and areal considerations and the information available.

4. Ascribing effects to a project

A uniform basis for attributing effects to a project is needed in order that results be comparable. The generally accepted basis is the "with" and "without" approach, in which the differences in expectations provide the basis for identifying appropriate project charges and credits. It is assumed that the goods and services used for project purposes normally are diverted from the least important uses otherwise expected. Accordingly, the cost in terms of market values usually provides an adequate measure of the value of benefits foregone.

The basis for determining benefits that may be credited to the project is similar. The project should be credited with the difference between values with the project and those expected from using the watershed resources in some other way without the project. The primary benefits attributable to the project are the total primary benefits, less the cost of the goods and services used that are not otherwise taken into account. As with costs, the value of the benefits produced is their exchange value, as measured by expected market price at the time of accrual.

The "with" and "without" approach becomes an analytical device for determining the effects of various purposes, features and incremental segments both in the evaluation phases of the economic analysis, as well as in project formulation. The amount of credit that is due to any addition (or deletion) in the program becomes the difference in the expected effects with and without the particular change under consideration. In providing a basis for measuring the effects of incremental benefits and costs, the approach is essential to the formulation of projects so as to maximize net benefits.

5. Basic assumptions

Evaluation standards and procedures should be based on consistent assumptions regarding economic trends and expected levels of resource employment. The assumption of a continuously expanding economy for

both "with" and "without" conditions would appear appropriate as a general basis for estimating price and requirement expectations. Under such a setting, increasing amounts of goods and services would be required to satisfy the needs of an expanding population and provide for higher levels of living. An eventual demand would develop for all types of goods and services that can be provided at reasonable cost. At the same time, it would be expected that other uses normally would be available for the resources required by the project.

This would result in resources ordinarily being considered scarce in the sense that all would be required under the economic conditions expected to prevail, either with or without the project. Resulting assumptions include the expectation that project required resources usually would be diverted from other uses; such diversions would be from marginal or least important other uses; and market prices would measure the values in such uses.

The high level of resource employment assumption does not preclude consideration of short run fluctuations in the economy. Allowances for unusual local situations may need to be included in the analysis of a specific project, including the lack of mobility of some resources.

B. Pricing Project Products and Services

The prices applied should reflect purchasing power values expected to prevail at the time benefits accrue or costs are incurred. Thus current prices or price relationships are appropriate for valuing costs of installation in the immediate future. Projected prices should be used for all effects occurring over time. These effects include benefits and costs of operation, maintenance, replacement and deferred installation.

Typical types of price projections for measuring future effects are: current prices, average prices over a period of years, "normalized" current prices, or definite price projections such as those prepared by the Department of Agriculture in September 1957.

1. Special pricing problems

State projections may require adjustment to reflect situations in particular watersheds. This usually involves adapting State projections to the watershed area on the basis of relationships between area and State prices during a base period. The projections used should be consistent for adjoining watersheds separated by State lines, which may at times necessitate the use of average relationships for combined areas and corresponding states. In general, it would appear feasible to make most of the necessary adjustments through applying conversion factors or price relationships computed from the price pamphlet directly to a comparable year base for the area.

Special consideration needs to be given the rare situations where project production is expected to affect previous price relationships.

Where project production is sufficient to cause a shift from a deficit to a surplus production area, such a change would need to be taken into account in the price projections applied. The use of past relationships in market areas comparable to those expected under project conditions may provide a basis for such adjustments. This special pricing problem is not likely to occur, however, on P. L. 566 watersheds, except in small isolated mountain basins or in sparsely settled areas in the West. Occasionally it may be a factor in river basin development.

Products for which price projections have not been computed should be estimated on the basis of available projections for the most nearly similar group.

C. Interest and Discount Rates

Interest and discount rates provide the basis for converting values estimated as of the time of accrual to a common time and risk basis. In an evaluation from either a private or public viewpoint, allowances must be made for any differences in time and uncertainty that may arise during the period between the investment of resources and the accrual of benefits. Prevailing interest rates for loans and investments in the Private Market may be regarded as reflecting both "time" and reasonably high "risk" components. In contrast, long-term investments in watershed protection and flood prevention reflect minimum "risks" components that suggest an interest rate lower than prevailing private market rates. Direct or specific allowances for risks of the predictable type should be made to the extent feasible when evaluating projects from a public viewpoint. This leaves the interest and discount rate as a measure of value differences due to time, together with residual risks and uncertainty.

1. <u>Interest rates</u>

As with prices for all types of economic goods and services, the need for an interest charge for capital stems from its scarcity. In order to be scarce, resources must be both wanted and limited in supply. The cost to society of capital utilization is determined by the productive opportunities over time that are foregone.

2. <u>Applicable rate</u>

Future project benefits will be discounted, project annual costs computed, and project benefits and costs converted to a common time basis by the use of current long-term Federal interest rates as issued annually by the Treasury Department.

Capital costs, such as land leveling or clearing, incurred by private beneficiaries to obtain the project benefits (associated costs) should be converted to their annual equivalent at the prevailing local interest rate for such expenditures.

D. Risk and Uncertainty Allowances

The evaluation of all projects involves projections into the

future where the outcome cannot be predicted with certainty. Allowances and adjustments may be necessary to reflect this situation. These allowances and adjustments may take the form of using a benefit to cost ratio significantly greater than unity, conservative estimates of benefits, contingency allowances, and periods of analysis short of expected economic or physical life or higher interest rates to allow for uncertainty.

E. Period of Analysis

The economic life of projects is limited by such factors as deterioration, obsolescence, depreciation, changing needs, and improvements in technology. Discount for time, and risk and uncertainly also limit economic life. The effective economic life is established at that point where the present worth of costs for extension exceed the present worth of the resulting benefits.

Economic life provides an appropriate basis for formulating the scale and scope of projects that serve the public interest. Formulation based on either a longer or shorter period would reduce net benefits.

1. Selected evaluation period

For purposes of project formulation and evaluation, the period to be used for estimating project benefits and costs should not exceed project economic or effective physical life or 100 years beyond the completion of project installation, whichever is less.

2. Evaluation period benefits and costs

The annual costs chargeable during the evaluation period include amortization with interest of initial installation costs; conversion of the costs of major replacements to be installed during the period to an annual equivalent; and operation and maintenance costs of a level sufficient to assure effective operating capacity to attain the level of benefits claimed for the project. The annual equivalent of replacement costs may well be considered as a type of operation and maintenance. The replacements are necessary for operation of the project, and the costs are to be borne by the sponsoring organization.

The benefits attributable to the evaluation period include those accruing over the period, reduced to an average annual equivalent, together with any remaining salvage productivity values available at the end of the period, reduced to an average annual equivalent.

CHAPTER 2

APPLICATION OF ECONOMIC ANALYSIS TO PROJECT FORMULATION AND ANALYSIS

I. GENERAL

This chapter treats the application of economic analysis in the actual project formulation process.

A. Objectives

The measurement of benefits and costs is an essential part of the process of formulating and evaluating project purposes that will be economically sound and give the best possible combination of eligible measures to meet project needs and objectives. In the formulation stage, it is necessary to consider existing and probable future economic conditions, the need for project development, the physical possibilities for project action and the most practical means available for realizing the desired objectives.

In a broad sense, the process of project formulation and evaluation, within the framework of the legal and policy constraints discussed below, is largely a problem of weighing alternatives. The overall planning objective is to select the measures or combination of measures that will meet the watershed needs and yield the greatest possible gain at the least cost.

B. Legal and Policy Constraints

There are a number of legal and policy constraints within which watershed projects must be formulated.

1. Some of the important legal constraints are: limits on the size of watersheds, size of floodwater retarding structures, flood prevention storage capacity in individual structures, etc. These and other legal constraints are contained in the Watershed Protection and Flood Prevention Act (P. L. 566, as amended).

2. Some of the more important policy constraints that influence project formulation are:

a. Land treatment measures are the basic element of any watershed project and shall be considered the nucleus or initial increment for project formulation. All other measures shall be justified for inclusion in the project on the basis that the land treatment measures scheduled for completion in the watershed work plan have been installed.

b. Agreement must be reached with the sponsoring local organization as to the level of protection to be provided for flood prevention and the objectives to be attained by each of the other project purposes included in the plan.

c. In project formulation, the requirements are: (1) The least costly system of structural measures needed to achieve the agreed-upon objectives in b above be developed to supplement the land treatment measures giving preference to floodwater detention as the means of affecting flood damage reductions. (2) Evaluate the benefits that will accrue to the system. (3) If the sponsoring local organization and the Service agree that it is desirable, increments may be added to the basic system to the extent that they produce benefits in excess of their costs.

C. Some Basic Principles

Within the framework of the constraints listed above, a number of important principles should be followed when using economic analysis in formulating and evaluating projects.

1. Projects shall be formulated initially to include all agreed-upon purposes which satisfy these criteria in quantitive terms:

a. Tangible net primary benefits exceed project economic costs.

b. Each separable unit or purpose provides benefits at lease equal to its costs.

c. The scale of development is such as to (1) meet project objectives, and (2) provide the maximum net benefits.

2. Plans should indicate the extent to which departures from the scope or scale of development are proposed in order to take into account intangibles or other considerations warranting a modification in the initially formulated plan. For example, a higher degree of flood prevention than is feasible on the basis of tangible benefits alone, may be justified where such protection is essential to protect against the threat to lives, health, or danger or serious economic dislocation. Or if long-range water needs are foreseeable in general terms where alternative means of meeting the needs are not available and additional capacity can be included initially at a significant savings over subsequent enlargement, such considerations may justify the additional cost required.

3. All reasonable alternatives that will accomplish the purpose and objectives of the project should be considered to the extent practicable and feasible during the process of project formulation and evaluation. Although flood proofing, flood plain zoning, and the like will be considered as a means of meeting project objectives, alternative cost comparisons will be limited to works of improvement authorized under the Act.

II. FORMULATION OF A PROJECT

During the process of project formulation, it is necessary to evaluate the physical effects of potential project measures in order that cost-benefit comparisons can be made. The benefits and costs should be estimated in accordance with the principles outlined in this and the

preceding chapter. Procedures for application of these principles in the measurement of benefits and costs of each project purpose are discussed in succeeding chapters of this Guide. In this chapter, evaluation procedural details will only be used to the extent necessary to illustrate the use of some of the important economic principles and concepts in project formulation and evaluation.

A. Determination of Watershed Problems

An essential first step in project formulation and evaluation is to locate, define and measure the significant watershed problems. This step involves answers to a series of questions, such as the following:

Is there a floodwater damage problem in the watershed? If so, what kind of damage occurs, its location and the annual amount in dollars? Is there a sediment damage problem? Where are the sediment source areas? What is the magnitude of sediment damage in dollars? Is there a need for irrigation or drainage, municipal and industrial water supply, recreational development, fish and wildlife development? Are there potentialities for more intensive or changed land use in the area? These and other economic and physical determinations will suggest possible solutions to the problems of the watershed. At this stage, the various physical solution possibilities can be evaluated in a preliminary way and the obviously unjustified means eliminated. Thus, economic analysis at this stage serves the important function of pointing out watershed problems, their location and their magnitude and suggests tentative solutions.

B. Economic Criteria on the Level of Development Needed

Economics has a function in determination of the project purposes and the degree of development to be sought. Projects should be planned to meet future needs insofar as they can be foreseen. Modifications of structures already built usually are more expensive and less satisfactory than inclusion of the features at the time of construction.

Economic analysis will point up the needs of a given area and potentialities for development. For example, the appraisal of opportunities for recreational development includes projections of population growth, analysis of potential competitive recreational possibilities, and consideration of complementary resources, as well as the physical possibilities of development.

The degree of development needed is directly associated with the potentialities of the area to be developed. In flood prevention, the degree of protection should not be the same for all watersheds but should be tailored to the values to be protected and the potential project induced land use changes. If an area is in truck crops where the direct production outlay is upwards of $100 per acre, a higher degree of protection is needed than if it were in small grain where the farmer has perhaps $15 of production costs invested per acre.

Consideration only of the existing situation is not enough. The planning should take into account the probable development in the future. Will an idle flood plain become productive if it is protected? What can be expected in the way of industrialization of an urban area if it is protected against flooding and an adequate water supply is provided?

It can be seen that the use of economics is not confined to the evaluation of a project already formulated. Instead it applies throughout the formulation process; to the purposes served, to the degree of development needed, and even to the location of measures to meet specific needs most efficiently.

C. Maximizing Net Benefits

From an economic viewpoint, the optimum scale of project development is the point at which the net benefits are at a maximum. Net benefits are maximized when the benefits added by the last increment of scale or scope of project development are equal to the cost of adding that increment. The increments to be considered in this way are the smallest increments in which there is a practical choice as to inclusion in or omission from the project. In watershed projects these increments usually occur as slugs rather than as smooth-curve type increases.

There are two places where this economic principle becomes applicable when formulating watershed protection and flood prevention projects.

The first is in that step in project formulation of developing the least costly set of measures to meet the minimum agreed-upon levels of protection and other project objectives. The essential point to keep in mind is that within reason all possible alternatives should be considered that will accomplish the objective at the least cost and at the same time maximize net benefits within the objective.

The second is in those cases where it is mutually agreed by the local sponsors and the Service, to strengthen the system of measures formulated in the first step by adding new increments so long as such additions will maximize net benefits at a higher level. This is illustrated by the data shown in table 2.1. It has been determined that structures numbers 1 and 2 will meet the objective of providing an adequate level of flood prevention at the least cost $12,800 annually and will provide an excess of annual net benefits over costs of $6,200.

Suppose it has also been determined through mutual agreement between the sponsors and the Service that a higher degree of protection than the minimum required to meet project objectives is considered to be desirable.

In order to establish the point where net benefits are at the maximum, further increments are added to the basic system of two structures and their incremental costs and benefits determined. By adding structure number 3, the annual cost is increased only $1,500 and the benefits increased by $1,700. The next increment, or structure number 4 can be added at a cost of $6,000 with an increase of $6,100 in benefits.

By adding structure number 5, costs are increased \$6,700 but benefits only increase \$5,000. Thus, the last addition has gone beyond the point of maximized net benefits because the cost of the increment is greater than its benefits. The total net benefits for the 5 structures will be less than for the system of 4 structures, \$4,800 as compared with \$6,500. Thus, the 4-structure system maximizes net benefits and would be the upper limit that could be included on the basis of tangible benefits alone and still comply with the policy constraint set out in I, B, 2, c.

Table 2.1 - Total Annual Costs and Annual Benefits; and Incremental Cost and Incremental Benefit for Alternative Floodwater-Retarding Reservoirs 1/

Structure	Annual Costs: Total	Annual Costs: Incremental Costs	Annual Benefits: Total Benefits	Annual Benefits: Incremental Benefits	Net Benefits 2/
(No.)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1 and 2	12,800	-	19,000	-	6,200
3	14,300	1,500	20,700	1,700	6,400
4	20,300	6,000	26,800	6,100	6,500
5	27,000	6,700	31,800	5,000	4,800

1/ Data are hypothetical.

2/ Total annual benefits minus total annual costs.

D. Evaluation Units

Each purpose to be included in a project must produce incremental benefits at least equal to its incremental costs. Therefore, project evaluation requires as a minimum the determination of the economic justification of each purpose. When a project includes several purposes it may be that some conflict and others are complementary. This is especially true with multiple-purpose structures where inclusion of several purposes may reduce the cost of each but create competition for a limited water yield or physical capacity.

Within a given purpose the first unit for evaluation should be the scale of development that will meet the minimum needs for that purpose. For example, if it has been determined that an irrigation project needs a firm water supply of at least 500 acre-feet annually, there is no point in evaluating a project that will supply but 250. Were the inadequate project to be installed, farmers probably would incur additional crop production expenses in anticipation of irrigation and find themselves in worse shape than if no water supply capacity had been provided. Likewise, inadequate flood protection may engender a false sense of security and encourage flood plain development too great for the risk remaining.

In project formulation consideration needs to be given to the interrelationship of structures. Such an interrelationship generally exists when a group of structures protect a common flood plain. Here the most economical system for attaining the agreed-upon minimum level of protection may be evaluated as a unit. However, other structures that

protect a discontinuous flood plain should not be included in this evaluation unit. An example would be structures on several streams that flow into a major flood control reservoir at separate points when there is no damageable area between them.

Policy, legal and other constraints must be considered in selecting the units for evaluation. It is possible that in some cases flood prevention benefits might be maximized if emergency spillway flows were permitted on an average recurrence interval of 10 years. However, if safety considerations dictate that such flows cannot be permitted more often than on an average of once in 25 years, it would be pointless to analyze the 10-year interval.

E. Planning a System of Single-Purpose Interdependent Structures

Usually, in planning projects, situations will be found where several proposed structures are interrelated in such a manner that each contributes to flood damage reduction in a particular reach or reaches of a flood plain, and removal of any one structure from the system will change the degree of protection afforded by the system. In this situation, the economic analysis can be handled in several ways, depending upon the amount of basic physical and economic data that will be available for analysis.

A simple approach is to select first a group or combination of structures that will give the desired level of protection at the least cost, then test the total group for economic feasibility. Under this approach, the group of measures selected for the first test of economic justification is obviously a very important step in the formulation and evaluation of a project. The skill with which this selection is made will influence the amount of future work required to formulate the most desirable project for the watershed. This selection necessarily depends on judgment in considering the degree of protection desired and the structures which appear most effective. If the ratio of benefits to costs for the selected group is favorable, and if mutually desired, the feasibility of adding successive increments to the system up to the point where benefits are maximized may be undertaken.

If the first group of structures do not prove to be economically feasible, alternative sets of structures that will meet the needs of the project could then be selected for evaluation. When this is the case, certain structures usually are "key" structures and would be needed in any alternative plan. The study often can be confined to selection of alternates for the less efficient structures. Unusually high cost structures can be examined to see if minor relocations can reduce costs.

F. Economic Evaluation of a Single Purpose Structure with Multiple Benefits.

In the economic analysis of structures designed for a single purpose, such as detention or storage of water, cases frequently will be found where the same reservoir capacity serves several uses that are incidental to its designed single purpose intended use. Some of these are: use of water in the sediment pool for stock water, irrigation, recreation,

fish and wildlife production. In such cases, the benefits from all uses may be lumped and equated against all costs in the economic analysis.

G. Establishing the Economic Justification and Scale of a Multiple-Purpose Independent Structure.

A typical situation encountered in project formulation and evaluation has to do with the economic justification of a multiple-purpose structure. For example, suppose it has been determined that a multiple-purpose structure, with 2,000 acre-feet of flood prevention capacity and 1,000 acre-feet of storage for irrigation will meet the needs and objectives of the sponsors. It has been determined that average annual benefits will be $1,404 for flood prevention and $1,566 for irrigation, a total of $2,970. The average annual cost of the structure, including operation and maintenance, will be $2,550.

Specific costs assignable to irrigation amount to $100 annually but there are none for flood prevention. The Use of Facilities method to allocate joint costs assigns $1,633 to flood prevention, and $817, plus $100 specific costs, to irrigation. This analysis indicates that the following situation exists, (Step 1):

Purpose		Benefit	Cost	Benefit Cost Ratio
		(dollars)	(dollars)	
Flood Prevention		1,404	1,633	Unfavorable
Irrigation		1,566	917	Favorable
	Total	2,970	2,550	Favorable

According to this analysis flood prevention is not justified. Thus additional steps must be taken to assure economic feasibility of each purpose. This will require the use of an alternative method of cost allocation.

Economic feasibility can be determined by using an incremental analysis as illustrated by the two examples to follow. Any one of the purposes may be selected as the first increment. Also, this first increment need not necessarily be economically justified, but as illustrated below, must be justified for inclusion in the project when considered as the last increment.

In the next example irrigation is the first increment selected for analysis and the cost of irrigation as a single purpose would be $2,000 annually. Addition of flood prevention as a second increment would increase annual costs by only $550 but would provide $1,404 in annual benefits. This situation would exist, (Step 2):

Purpose	Increment	Benefit (dollars)	Cost (dollars)	Benefit Cost Ratio
Irrigation	First	1,566	2,000	Unfavorable
Flood Prevention	Second	1,404	550	Favorable
Total		2,970	2,550	Favorable

By this analysis irrigation has an unfavorable benefit to cost ratio even though the benefit cost ratios for flood prevention and the structure as a whole are favorable.

The analysis is carried further by treating flood prevention as the first increment and then adding irrigation. This analysis, produces these results, (Step 3):

Purpose	Increment	Benefit (dollars)	Cost (dollars)	Benefit Cost Ratio
Flood Prevention	First	1,404	1,912	Unfavorable
Irrigation	Second	1,566	638	Favorable
		2,970	2,550	Favorable

In this instance, flood prevention has an unfavorable ratio and that for irrigation as well as the whole structure is favorable. Note, however, that flood prevention in step 2 and irrigation in step 3 both have a favorable ratio as the last increment and that the overall benefit-cost ratio is favorable.

Of course, if both purposes were shown as being justified during the course of a given step in the analysis, steps 1, 2 and 3, further examination would not have been needed.

Steps 2 and 3, illustrate two significant points in the economic analysis of multiple-purpose independent structures. First, a purpose selected as the first increment for analysis, if not justifiable as that increment, must be justifiable when considered as the last increment if it is to be included in the project. Furthermore, if the structure or purpose is to be included in the project, the total benefits from all purposes must exceed the total costs of all purposes.

The procedure illustrated in steps 2 and 3 is applicable also to the addition of storage capacity for a single purpose. The process can be continued until the last increment costs more than it returns in benefits or until legal or physical limits on capacity are reached.

CHAPTER 3

FLOODWATER DAMAGES AND BENEFITS

This chapter describes the appraisal of floodwater damages and benefits. It first outlines the evaluation background. Then it describes general methods of determining average annual floodwater damage. It discusses considerations in appraising most of the different types of floodwater damage such as agricultural, urban residential, industrial and commercial; and transportation. The final sections of the chapter consider flood prevention benefit-cost evaluation.

For the most part the discussion is confined to the application of economic principles to the problem at hand, and general methods of accumulating and analyzing data for evaluation purposes. No attempt is made to prescribe step-by-step procedural details. The diversity of conditions found would cause such an approach for nation-wide application to be more harmful than beneficial.

I. GENERAL CONSIDERATIONS IN DAMAGE APPRAISAL

Damage appraisal for project evaluation involves a comparison of the damage that can be expected without the project and that which will occur after the project is installed. Proper appraisal requires a projection of physical and economic conditions during the life of the project. The present condition is merely a convenient benchmark from which to estimate future conditions without and with the project. This projection into the future is most difficult.

A few of the problems often encountered in making these projections are outlined below. (1) Perhaps sediment is filling the channel so that if nothing is done flooding will become more severe. It may become so serious that cultivation of most, or all, of the flood plain will be abandoned. (2) On the other hand, there may be channel degradation or bank cutting which will increase the size of the channel if nothing is done. Then flooding can be expected to become less frequent and severe, or land may be lost from production. When either of these conditions exist, the economist is dependent upon both the geologist and hydrologist for projections of the physical conditions. (3) Agricultural trends must be considered. It may be that the type of agriculture is changing and is affecting the land use pattern. Technological progress in agriculture is causing marked increases in yields. The economist must consider how these advances will affect crop and pasture yields during the life of the project. Even though the project were not installed, technological progress can be expected. Changes brought about by improved technology **should not** be confused with those caused by recovery from land damage as described in Chapter 5. They also should be kept separate from yield increases that arise from the fact that greater advantage can be taken of technological improvement if flood risks are reduced. Increases of this type

are described in Chapter 4. (4) Non-agricultural values are increasing constantly. They may take the form of residential or industrial developments encroaching upon the flood plain. Or they may arise merely from higher values attached to existing development. For example, the constantly rising standard of living has resulted in the average residence containing appliances that were unknown 20 years ago.

Many different methods may be used in making projections of future conditions. The method used will depend upon the given situation. Mere extrapolation of existing trends generally is not sufficient. The economist will need to gather and evaluate sufficient background data to form a basis for sound projections.

II. MAJOR METHODS OF CALCULATING AVERAGE ANNUAL DAMAGE

The measurement of floodwater damages and the benefit from reduction of damage usually is done by one of four methods. Each of the methods may be specially applicable to particular situations. This section describes each briefly.

A. Frequency Method

The frequency method used in flood damage appraisal involves the establishment of relationships between the physical and economic flood characteristics and the probable frequency of flood occurrence.

The physical appraisal involves establishing the relationships of the physical characteristics of floods to frequency of their occurrence. These associations, generally expressed by means of graphs, include the following:

1. Runoff related to frequency of occurrence -- obtained either through conversion of rainfall to runoff, or from runoff as measured by stream gages.

2. Runoff versus discharge (cfs).

*3. Discharge (cfs) versus frequency.

*4. Discharge (cfs) versus flood stage.

5. Flood stage versus area flooded.

The economic appraisal involves establishing and relating monetary values to the physical flood characteristics and to frequency of flood occurrences. These associations, generally expressed by means of graphs, include the following, which are developed as needed to evaluate different types of floodwater damages.

1. Area flooded versus damage.

*2. Flood stage versus damage.

3. Discharge versus damage.

*4. Damage versus frequency of occurrence.

*Samples of these graphs are illustrated in Figures 3.1 through 3.4. Such graphs make possible the computation of average annual flood damages for the stream reach covered by the graph.

1. Stage-Damage

Flood damage surveys provide the basis for formulating this curve (Figure 3.1). The height of an experienced flood is used as the base point from which stages of other experienced or potential floods are referenced. Damages are appraised for sufficient stages to define the shape of the curve adequately. Columns 1 and 2, table 3.1, illustrate this phase of the frequency method.

2. Stage-discharge and discharge-frequency

Details of the construction of stage-discharge and discharge-frequency graphs are given in Chapters 14 and 18, respectively, of the Hydrology Handbook - for watershed planning.

Figures 3.2 and 3.3 and columns 3 and 4 of Table 3.1 indicate application of these data in the procedure.

The damage-frequency curve, figure 3.4, is drawn through the plotted values of corresponding damage and frequency. The values used in producing this graph are shown in Table 3.1. Average annual damage is determined from the damage frequency curve by the following calculations:

a. Planimeter in square inches the area enclosed by the curve.

b. Determine the product of the values of the abscissa and the ordinate at the point one inch from the point of origin. This value determined from figure 3.4 is obtained as follows: abscissa one percent, ordinate $100,000, giving a product of $1,000.

c. Product of the total square inches measured in a. (13.39) and unit value per square inch determined in b. ($1,000) is equal to average annual damage ($13,390).

Table 3.1 - Reach No. 4 ______ Creek
Damages Resulting from Floods of Different Sizes and Frequencies

Flood stage in relation to flood of 6/15/45 (Feet)	Damage (Dollars)	Peak Discharge (c.f.s.)	Chance of Occurrence 1/ (Percent)
+ 2	1,000,000	4,200	Less than 1
+ 1	720,000	3,450	Less than 1
6/15/45	410,000	2,800	1.4
- 1	110,000	2,000	3.2
- 2	10,000	1,500	6.0
- 3	0	1,200	7.5

1/ Frequency of occurrence may be expressed in several ways, each of which may be converted to the other. The term used herein should be interpreted to mean the percent chance of a given peak discharge being equalled or exceeded in any one year.

The frequency series offers an approach to computing average annual damages by weighting the effect of all floods without estimating losses separately for each flood in a long series of events, thereby providing an estimate at a saving of work over the historical series method. Thus, when conditions are suitable for its use, such as when damageable values can be restored between floods as in residential areas, it is the preferable method.

The seasonal distribution of floods must be taken into account when evaluating crop and pasture damages. This is necessary because of the difference in flood damage resulting from given flood stages during different periods of plant growth. The relative frequency of flooding by seasons or months furnishes the basis for making the adjustment. (Methods for making this determination of seasonal frequency are described in Chapter 18, Hydrology Handbook - for Watershed Planning).

Upon the determination of the seasonal distribution of flooding, a composite acre value for each stage is developed and the damage is calculated for each time period, usually by months of the growing season. The composite acre damage for each time period is then weighted by applying the percent likelihood that a damaging flood will occur. The weighted damage by time periods is then totaled to determine the annual composite monetary damage (See Table 3.2). This calculationn makes possible damage estimates by flood stages leading to the development of a stage-damage curve for the reach.

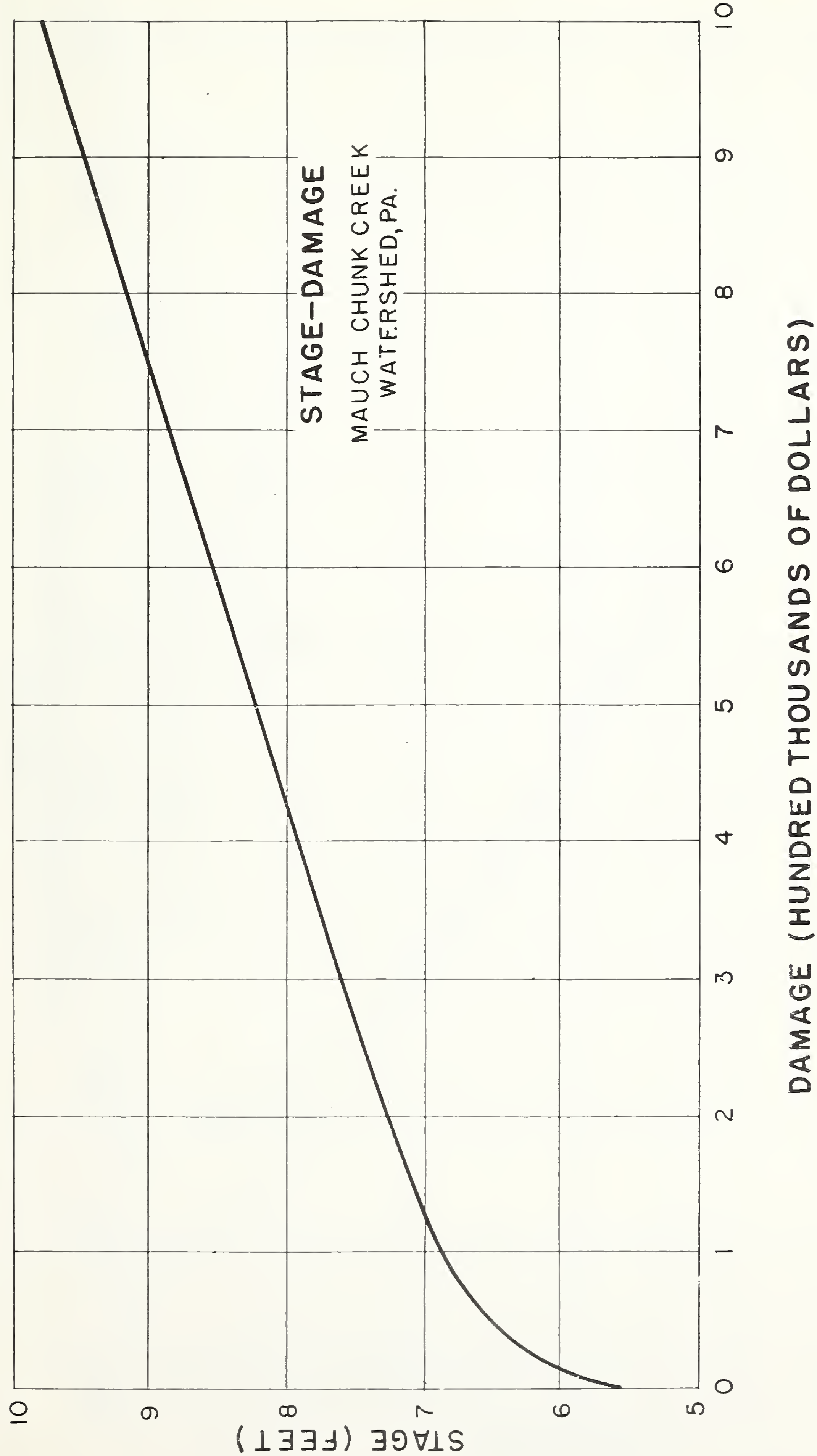

STAGE–DAMAGE
MAUCH CHUNK CREEK
WATERSHED, PA.
DAMAGE (HUNDRED THOUSANDS OF DOLLARS)
STAGE (FEET)
0 1 2 3 4 5 6 7 8 9 10
5 6 7 8 9 10

Figure 3.1

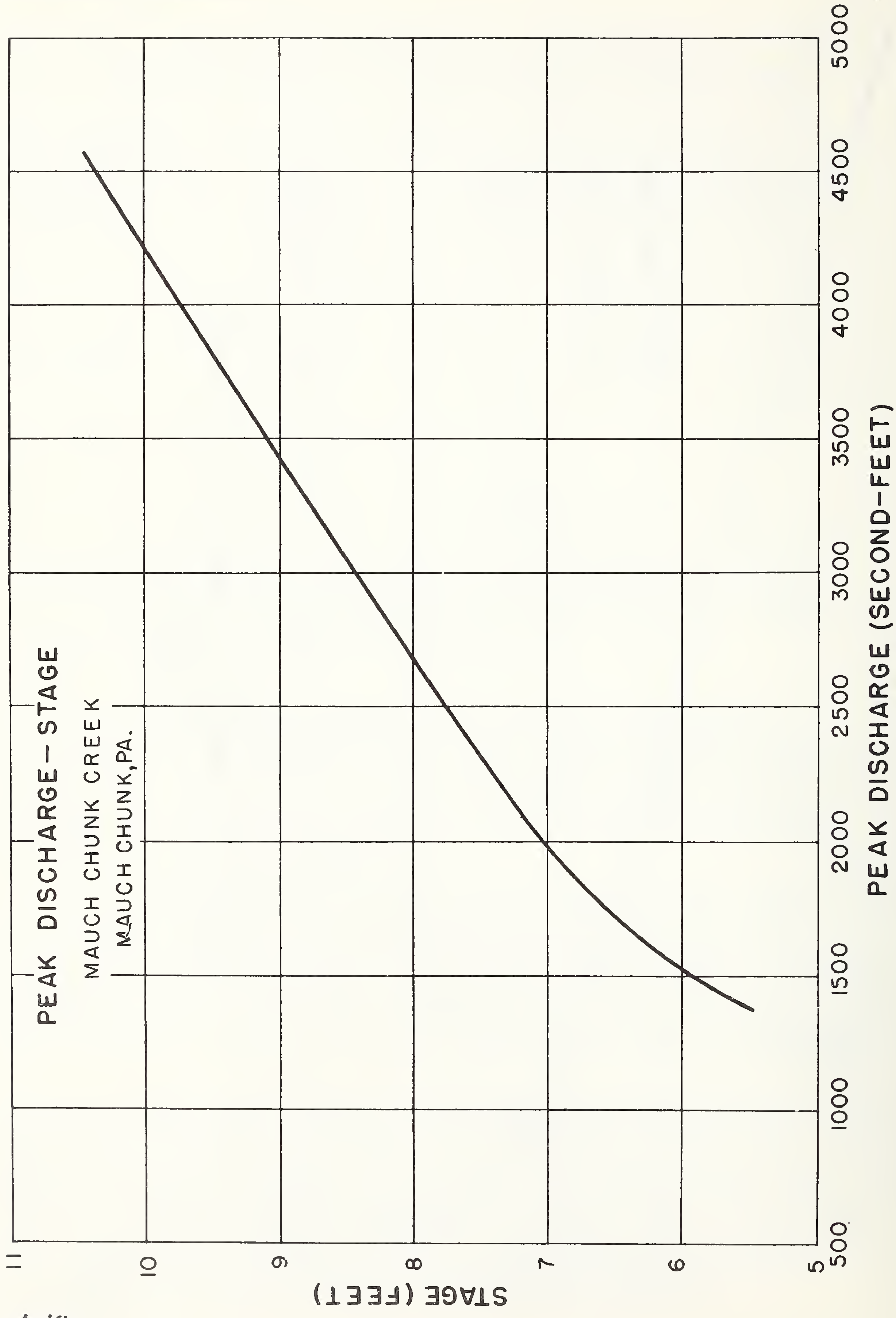

PEAK DISCHARGE – STAGE
MAUCH CHUNK CREEK
MAUCH CHUNK, PA.
PEAK DISCHARGE (SECOND-FEET)
STAGE (FEET)
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5
6
7
8
9
10
11

Figure 3.2

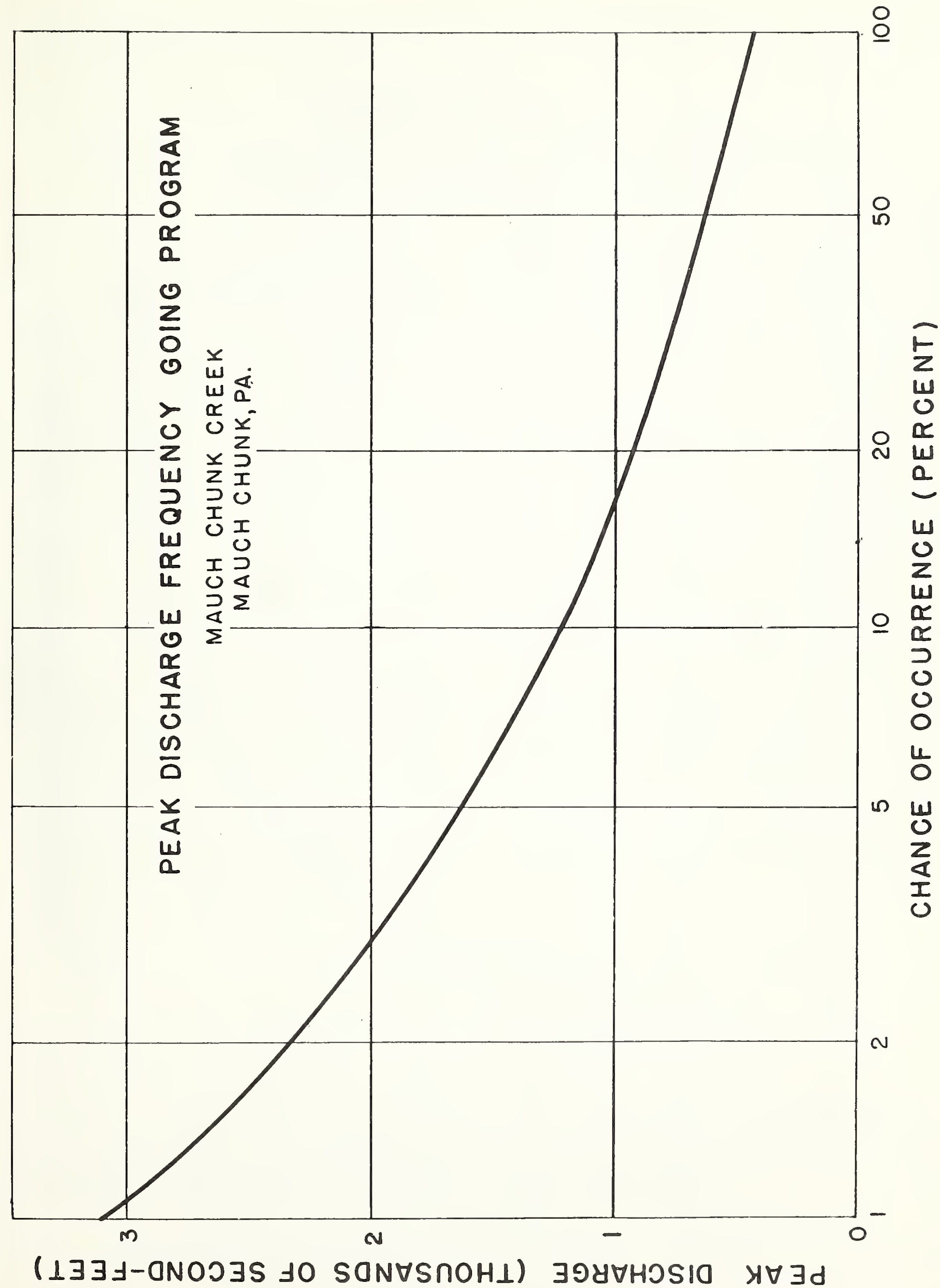

PEAK DISCHARGE FREQUENCY GOING PROGRAM
MAUCH CHUNK CREEK
MAUCH CHUNK, PA.
CHANCE OF OCCURRENCE (PERCENT)
PEAK DISCHARGE (THOUSANDS OF SECOND-FEET)
1
2
5
10
20
50
100
0
1
2
3

Figure 3.3

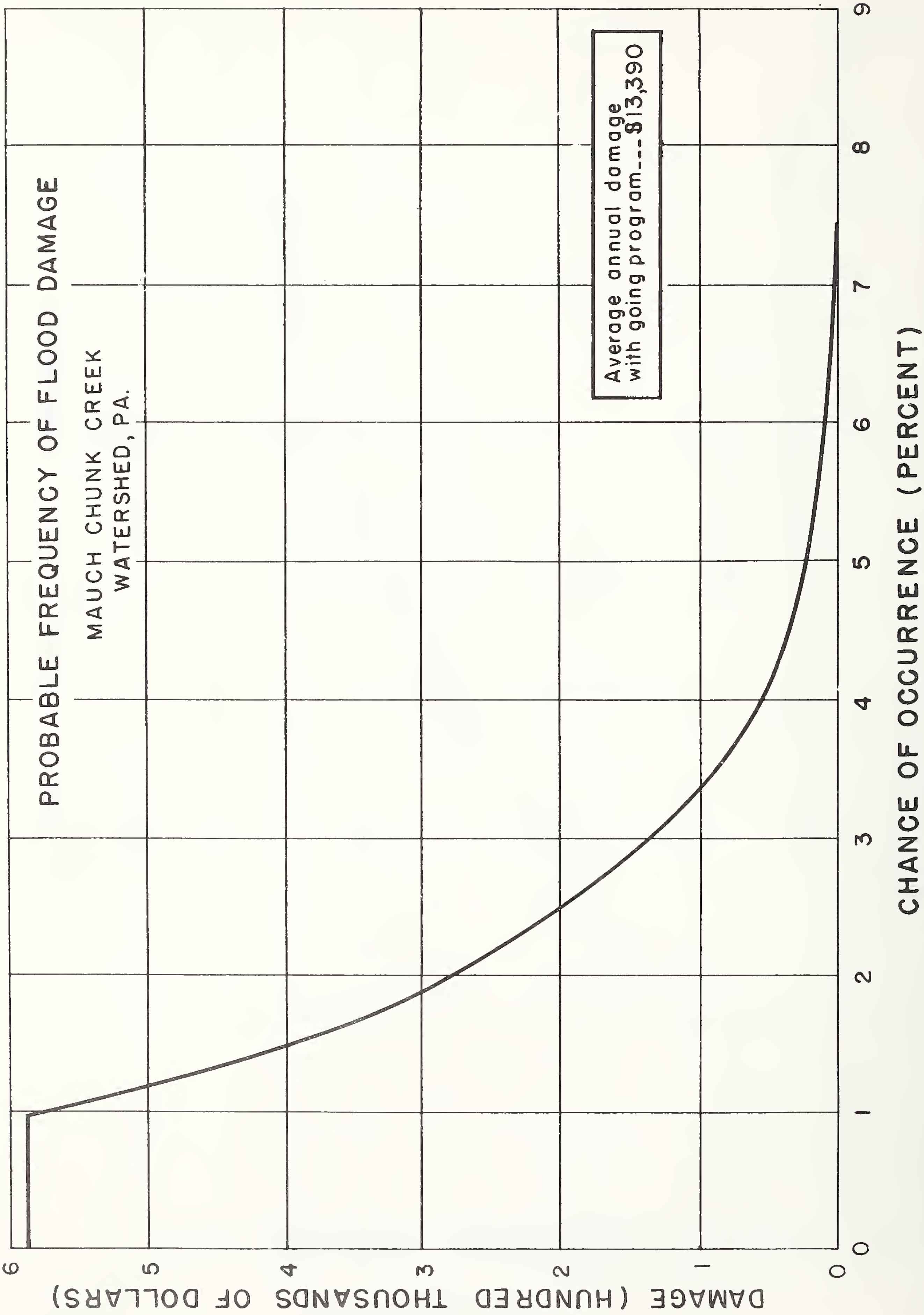

PROBABLE FREQUENCY OF FLOOD DAMAGE
MAUCH CHUNK CREEK
WATERSHED, PA.
Average annual damage
with going program....$13,390
CHANCE OF OCCURRENCE (PERCENT)
DAMAGE (HUNDRED THOUSANDS OF DOLLARS)
0
1
2
3
4
5
6
7
8
9

Figure 3.4

TABLE 3.2

Frequency Method

Sample Calculation of Cropland and Pasture Stage-Damage Relationship at 2' Stage for Reach I

Time Period	Damage at 2' Stage per Composite Acre ($)	Percent Chance of Flood Occurrence in any 1 Year	Weighted Per Acre Damages ($)
January	0	5	0
February	0	5	0
March	.48	15	.07
April	1.35	15	.20
May	6.85	5	.34
June	20.00	5	1.00
July	56.00	5	2.80
August	61.00	5	3.05
September	32.00	10	3.20
October	15.00	15	2.25
November	1.80	8	.14
December	0	7	0
TOTAL	xxx	100	13.05

Number of acres in reach at 2' stage = 85 acres.

85 acres x $13.05 damage per composite acre = $1,109.25 crop and pasture damage in Reach I at 2' stage. (Although the value calculates to $1,109.25, it is suggested that it be rounded. In this case for plotting purposes $1,100 probably would be the limit of accuracy.)

When crops are flooded more frequently than once a year, the damaging effect of the succeeding flood is altered by the effects of the previous flood. Two 100 percent chance events occurring during a given crop year will produce less total damage than if they were to occur in successive years, although the probability of either sequence is about the same. Therefore, it is necessary to adjust the crop damage estimates to account for recurrence of flooding. It is essential that the method of adjustment take into account the fact that if the project is effective a greater adjustment will be needed for non-project than for project conditions. The project can be expected to eliminate some recurrent flooding.

B. Historical Series Method

In using the historical series method, an evaluation period is selected where the cumulative annual departures from normal precipitation are minimized. Essentially this method rests upon the assumption that a sequence of events that has occurred in the past also may occur in the future. Floods of extreme magnitude (usually those with an expected recurrence interval of twice the evaluation period, or longer) should be excluded from the series unless appropriate adjustments are made.

After each of the various categories of damage have been appraised for each flood during the evaluation period under future conditions without the project, they should be summed and divided by the number of years in the period. The answer is the unadjusted average annual damage. The figure is then adjusted for recurrent flooding, or otherwise as needed, to obtain the average annual damage.

Caution should be observed with regard to the evaluation period. It often happens that the period of record of stream gages or rain gages involves fractional parts of a year. Evaluation periods should comprise complete years, dropping all fractional periods from consideration. Unless floods occur annually, an error may be introduced by starting and ending the evaluation period with floods. For example, flood damages may be estimated for a period of 20 years (1937 - 1956 inclusive) during which time 7 floods occurred. An examination of the record (or other reliable sources) shows that the last flood previous to 1937 occurred in 1934. Hence the flood period covers more than 20 years.

The flood series should be adjusted by dropping from consideration small floods that occur in such close proximity to larger ones that restoration of damageable values would not be possible.

Stage-damage curves are developed when the historical series method is used. As the dates and sequence of flooding are available, separate curves usually are developed by months or seasons. When depth of flooding is the chief determinant of the rate of crop damage from a given flood, the hydrologist may develop curves which relate the

acreages flooded within different depth zones to flood heights. A sample of a set of curves of this type is shown in figure 3.5. It is assumed for illustration that during the spring season, the crop damage along this reach for different depths of flooding are:

0 - 1 foot - $3.00

1.1 - 3 feet - 5.00

Over 3 feet - 7.00

The acres flooded at different depths by flood stage from figure 3.5 multiplied by these damage rates will provide the basis for development of figure 3.6.

Then figure 3.6 illustrates the appropriate stage-damage curve for crop damage in this reach from spring floods.

It is possible in the historical method to develop a single stage-damage curve for the entire year by weighting the damage factors by the seasonal occurrence of flooding. However, this procedure results in little, if any, saving in time.

When using the historical series it generally is found that several floods occur during a single year. In other years there may be no flooding. In such cases it is incorrect to add the unadjusted damage to crops and pasture for each flood in the evaluation series and use the sum as the total damage. The first flooding during the year will reduce the value of the crops somewhat so the second flood will find less value to damage. Some portion of the value sometimes may be restored between floods through replanting or otherwise but the yield of the late crop usually will be reduced. One method of calculating these changes in value, and in resulting damage, is by making a flood-by-flood analysis. These calculations are laborious when an evaluation series includes a considerable list of floods.

Calculations of this type have been used to develop empirical short-cut formulas to adjust damages for recurrent flooding. One such formula used in several states is represented by the equation $1/Y = 0.7706 + 0.2387X$. Here X is the sum of the areas flooded by all floods in the series divided by the sum of the areas flooded by the largest flood each year. Y is the percentage of the damage, as calculated from the individual flood events, to be used in correcting for recurring floods. This equation does not provide for restoration of value between floods.

An example of the correction under this equation follows: The total acreage flooded by all floods in a 20-year period was 200,000 acres. There was no flood one year and the sum of the acreages flooded by the largest flood each year was 80,000 acres. X therefore equals 200,000/80,000 or 2.5. The average annual damage found by considering

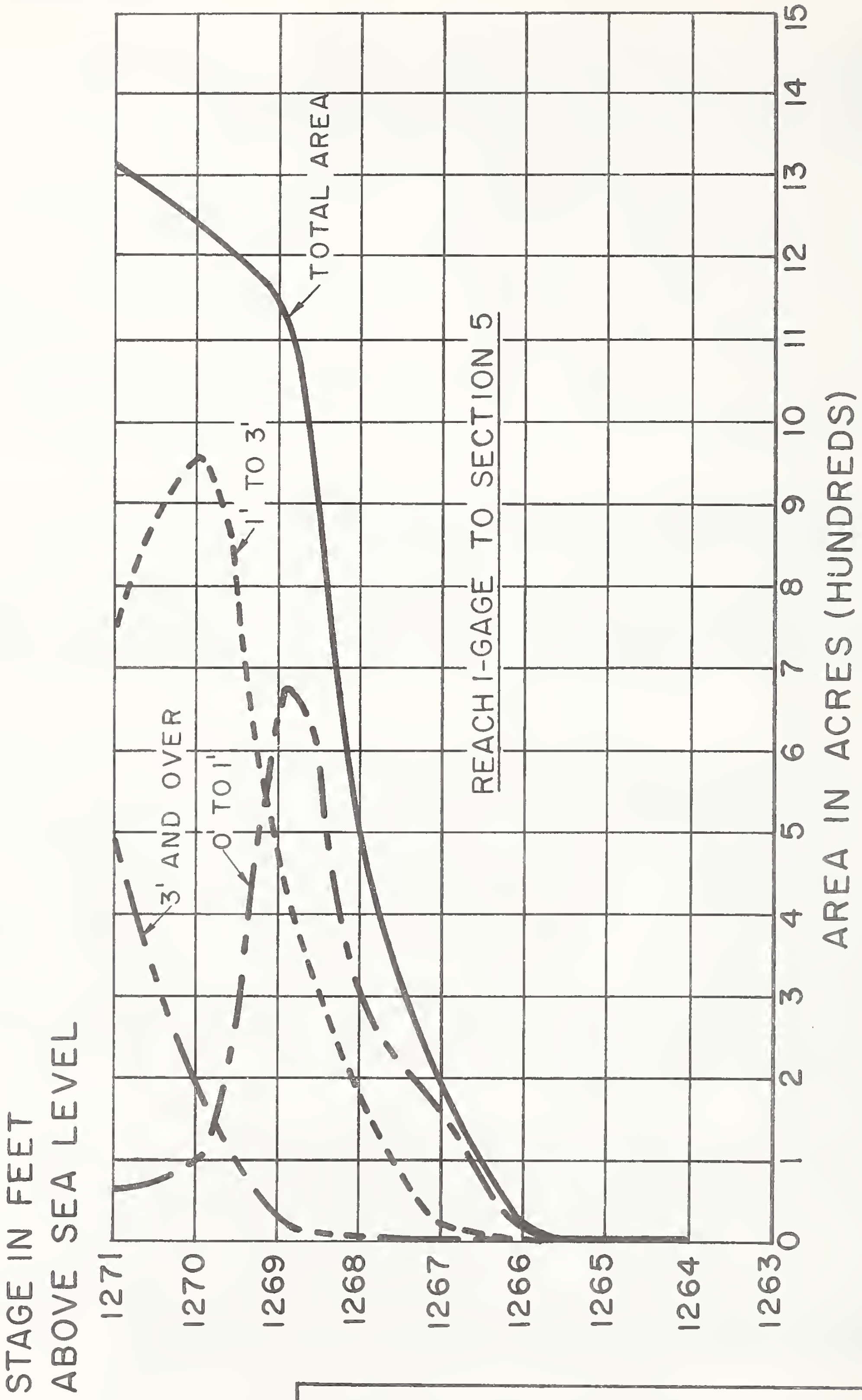


Figure 3.5
INUNDATED AREA CURVES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

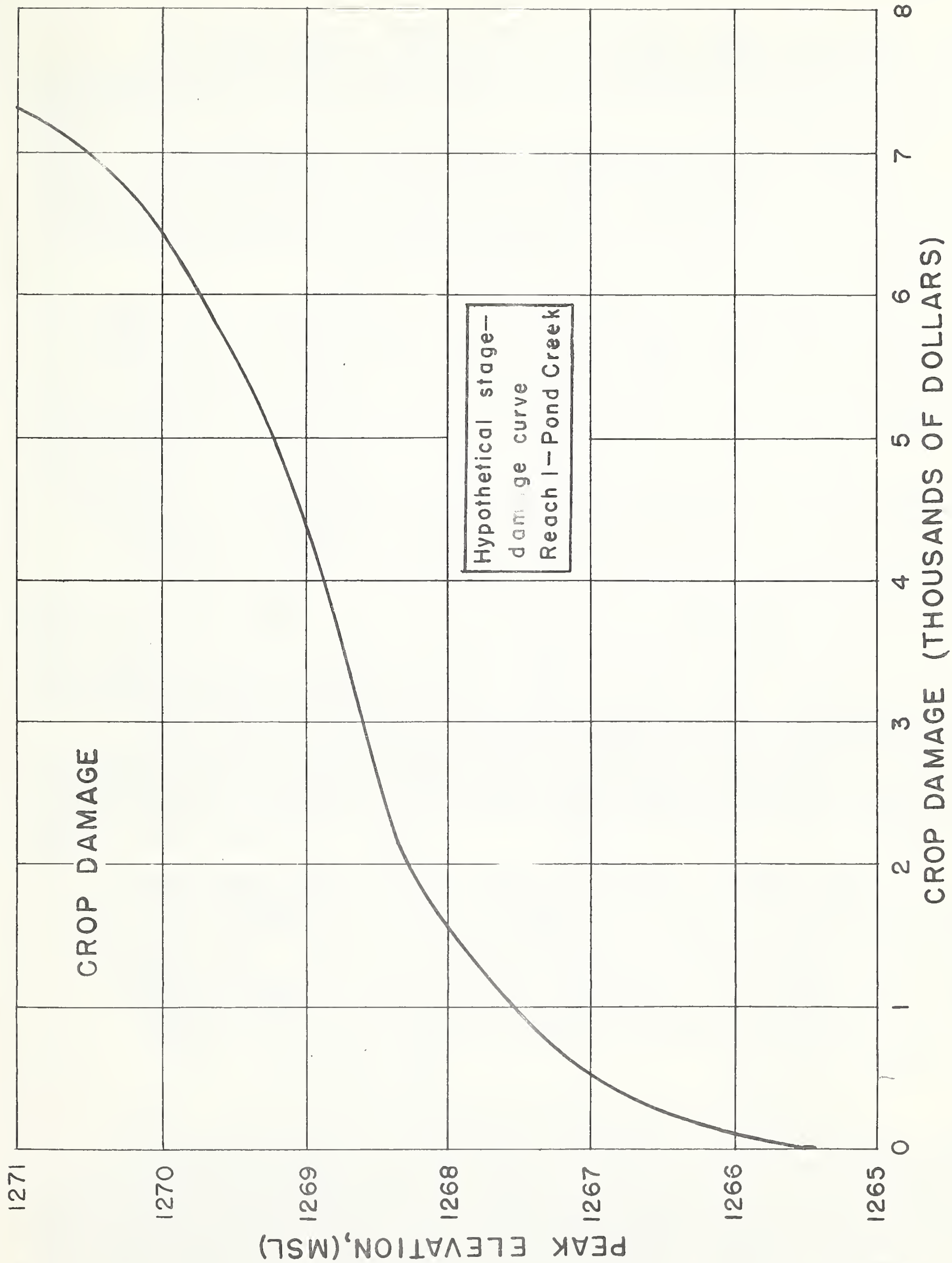

CROP DAMAGE
Hypothetical stage-damage curve
Reach I—Pond Creek
CROP DAMAGE (THOUSANDS OF DOLLARS)
0
1
2
3
4
5
6
7
8
PEAK ELEVATION,(MSL)
1265
1266
1267
1268
1269
1270
1271

Figure 3.6

each flood separately was $50,000. Substituting in the formula, $1/Y = 0.7706 + 0.2387\ (2.5) = 0.7706 + 0.5968 = 1.3674$. Then $Y = 0.7313$ and the adjusted average annual damage would be $50,000 x 0.7313 or $36,565.

The approach gives less correction for recurrence under project conditions than for conditions without project. Such a result is in accord with experience. The project is likely to eliminate a number of small floods but it probably will have less effect on the large ones. Hence there is less recurrent flooding.

In the states where it is used, the equation has been tested repeatedly and found to give results which seldom differ by more than two percent from those obtained through a flood-by-flood approach. Presumably in other areas of the country where growing seasons and crops are different, a somewhat different equation should be derived.

The historical series method requires somewhat more work for the hydrologist and economist than does the frequency method. However, when flooding is frequent and the major damage is to crops and pasture it allows a positive approach to the adjustment of damages from recurrent flooding.

C. Overland Flow

In some watersheds tributary ephemeral streams may discharge their floodwater onto alluvial areas with no defined channel to the main watercourse. Usually these alluvial areas are flat or only gently sloping in both directions and the floodwater spreads out until the flow eventually is dissipated. This situation wherein there is virtually no channel or where the possibility of lateral spreading is great is called overland flooding.

Under natural conditions, these alluvial areas were natural spreading areas for runoff. Because of favorable topographic and soil characteristics many have been developed into highly productive farming areas and in some cases into urban and suburban areas. The increased value of property and its greater susceptibility to damage, together with the inability of individuals to protect their property because of the unpredictable path of the flood flows, has created serious local flood problems.

Peak discharge and flood stage have little meaning in overland floods. When the floodwater emerges from the confined section onto the alluvial fan or plain the flood peak quickly flattens. As a result, the area flooded is not a direct function of the peak discharge except as it may overtop diversion dikes built to direct its course away from a portion of the flood plain. More often, the area flooded is directly related to the flood volume. The greater the volume, the greater is the area flooded.

The relationship is illustrated in the White Tanks Watershed in Arizona. Floodwater from this watershed debouches from the White Tanks Mountains onto a highly productive gently sloping flood plain. Once the floodwater breaks through the highline irrigation canal, it spreads out over the farm land in relatively shallow sheet flows except where it is concentrated or obstructed by railroad and road fills, ditches or other man-made obstacles. It seldom reaches the Agua Fria or Gila Rivers. The relationship between flood volume and acreage flooded is shown in the following tabulation:

Flood Date	Volume Acre-Feet	Acres Crop Land Flooded	Acres Flooded Per Acre-Foot
August 1939	3,500	4,600	1.3
September 1956	7,000	7,500	1.1
September 1949	2,500	3,000	1.2
January 1951	5,500	7,000	1.3
July-August 1951	11,500	14,100	1.2
Total	30,000	36,200	1.2

A large area of cropland in this watershed lies in the flood plain. Not all would be subject to flooding by a single flood, but most is subject to the flood hazard by slight changes in the paths of flood flows. Even the 100-year flood would inundate only about 25 percent of the flood damage area.

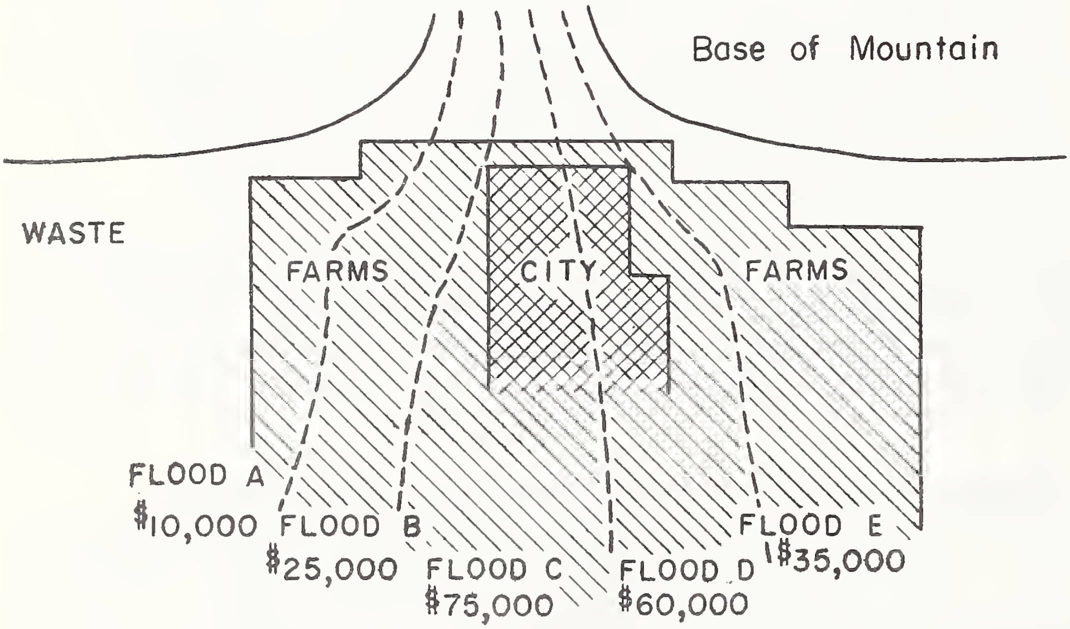
In overland flow situations with relatively little ponding, farm damage per acre flooded appears to be relatively constant irrespective of the size of the flood. This is illustrated again in the following tabulation for the White Tanks Watershed for two floods, both of which occurred in August.

Type of Damage	1939 Flood	1951 Flood
Crop	$28.75	$28.60
Land	8.89	10.14
Farm ditches	3.91	3.60
Miscellaneous farm damage	1.69	3.11
Total farm damage/acre flooded	$43.24	$45.45

Since the 1951 flood was over three times as large as the 1939 flood, it was concluded that flood damage was proportional to the acreage flooded, which in turn was proportional to the flood volume. Hence, it was necessary only for the hydrologist to determine a flood volume-frequency series to provide a basis for determining average annual flood damages over a normal hydrologic period.

Overland floods seldom follow the same path. During the interval between floods, even minor changes in the flood plain such as small dikes, road and railroad fills, irrigation ditches or even land leveling have been known to alter the course of flood flows. Sediment deposition where there is an abrupt change of grade is also an important factor in altering their course. This unpredictability is not particularly important where there is homogeneity in the flood plain. However, many alluvial fans or other alluvial areas exhibit a wide variety of damage potential due to differences in kind and extent of development. If a flood strikes the developed area of the flood plain serious damage may result, whereas if it followed a path through the undeveloped area little or no damage would occur. Hence, it is necessary in such situations to determine the mean damage resulting from a flood of certain size, taking into consideration the probability of the flood following any one of several possible paths.

This problem is illustrated in the following sketch:



Through the use of topographic surveys, aerial photographs, and maps of historical flood flows, flood paths A, B, C, D and E are traced through the flood plain. Flood damages are determined from known relationships between damages, flood depths, and velocity. If a flood of the magnitude being studied has an equal chance of following each of the flood paths then the probable damage from such a flood is equal to the mean value of the five alternatives which in this example is $41,000. Similar studies made for floods of different magnitudes would furnish the basis for damage-discharge curves.

In the arid regions where the overland flow technique has been used most frequently, there are only a few floods in a 20-year period. The few gage records that exist indicate that even when floods are so infrequent, there are generally two or three years during which more than one flood occurred. However, recurrent flooding during a single year over the same area is unlikely because of the alternative paths the flow can take.

Either the historical series or the frequency method may be used in the overland flow analysis. The distinction between overland flow and the usual methods of analysis is that here the hydrologist determines the total flood volume instead of flood routing to establish peak flows.

D. Net Income

A method which theoretically is sound, but which is likely to have practical difficultues, is the evaluation of flood damage and the benefit from its reduction through the change in net income after project installation. This procedure is applicable where nearly all damage is to crops and pasture and the control of flooding after project installation will be almost complete. It also is used in most cases where inseparable flood prevention and agricultural water management benefits are being evaluated.

The procedure consists of determining the land use, average crop yields and net return without project and comparing these with flood-free yields, the degree of restoration to former land use, and the net return under project conditions. The difference in the net return constitutes the flood damage. The increase in the net return over non-project conditions as a result of project installation constitutes the project benefit through reduction of damage. Additional benefits may accrue through increasing the intensity of land use beyond that which has been attained in the past. In most cases, as in combined flood prevention and drainage, there is no need to separate the benefits from restoration from those resulting from land use change or intensification.

A major difficulty is to determine how closely the average crop yield after project approaches the flood-free yield when protection is incomplete. Another problem is the determination of additional production costs under these circumstances.

Nevertheless, this procedure can shorten greatly the work required for damage appraisal. The effect of recurrent flooding is considered automatically in determining the yields and land use under non-project conditions.

III. STEPS IN DAMAGE APPRAISAL

The following outline of steps necessary to appraise floodwater damages adequately is applicable to many varied situations. Unusual conditions may require some adaptations. Understanding of the principles involved will provide a basis for making the adaptations necessary to cope with unusual problems.

A. Selection of Areas for Study

To obtain statistically reliable data in watersheds covering only a few square miles, it may be necessary to obtain information on the entire flood plain. However, a sampling procedure should be employed where practical. On larger watersheds a sampling procedure usually should be employed in all cases.

The first step in selection of a sample for detailed investigation is a careful reconnaissance of the whole area to be studied so that all major problems or conditions will be sampled. Stereoscopic analysis of flood plain photographs will be useful.

The selection and use of appropriate stream and flood plain reaches provide a means for (1) identifying the location of damages and benefits; (2) bringing the evaluation of hydrologic and economic data together for determination of stage-area-damage relationships; and, (3) relating damage reductions or other benefits to works of improvement.

In setting up the sample of areas for detailed investigation, attention to these points is important:

1. Important variations in flood plain characteristics and in land use should be considered. (An example of this would be where a flood plain crosses two or more problem areas or if an urban area is involved.)

2. Both sides of the stream should be represented.

3. Differences in channel size and valley width from the headwaters to the bottom reaches should not be overlooked.

4. Portions of the flood plain should not be excluded from the possibility of being drawn in the sample for any reason.

5. The selection should facilitate separate evaluation of individual structures or groups of structures.

B. Collection of Basic Data

1. Maps

Major land use in the flood plain may be mapped on aerial photos, overlays, or sketches, depending upon the need. The map should show improvements such as roads, buildings and bridges subject to damage. Where urban and residential areas are subject to flooding it is desirable to use a detailed map. Many towns and cities have maps that will help fill this need. Land use capability classes and soil delineations also may be shown on the flood plain map. It usually is not necessary to show crop distribution throughout the flood plain, however, it will be desirable to show crop distribution in a few representative sample valley sections. Locations of areas significantly affected by flood plain scour, deposition and streambank erosion may be delineated on the map to complement the investigations of the geologist.

2. Cost and Price Data

Production cost data usually are available from State Colleges of Agriculture. Local agricultural workers can assist in providing information on the farming operations common to the area. Most of the Engineering and Watershed Planning Units have developed costs of producing various crops applicable to fairly wide areas such as a Land Resource Area. If a given operation, such as combining, usually is done on a custom basis in a community, the custom price may be considered as a cost of operation.

When using cost data from the various sources, care should be taken to check its applicability to watershed planning. The following are among the points to consider. The price base should be known so that prices can be converted to projected levels. The economist should find out exactly what items of cost his data include. Among these are interest and depreciation of equipment, labor whether hired or unpaid family, and cost of obtaining and applying fertilizer and insecticides.

3. Collection of Field Information

Information regarding damages experienced may be obtained from the operators of flood plain land. It is recommended that this information be recorded on a flood damage schedule rather than loose notes to make sure that comparable information is obtained from all respondents. Figure 3.7 is a sample schedule illustrating the general type of data needed.

This information will furnish basic data for estimating damageable values and rates of damage for all classes of agricultural property or will provide the basis for making adjustments to standard damage data already developed.

Flood Damage Schedule Work Sheet
(Sample)

Name ____________ Years on Farm ____________ Subwatershed ____________

Flood of ____________ Acres Flooded ____________ How frequently do floods of this size occur ____________

Acres Flooded by Largest Flood ______

NOTES

Damage to Crops and Pasture From Flood of Above Date

Crop	Depth	Acres Flooded	Present Acres This Crop	Expected Yield If No Flood	Yield After Flood	Extra Cost: Kind	Extra Cost: Amount	Expenses Saved: Kind	Expenses Saved: Amount
Cotton	0'-2'	10	5	200 lb.	150	Replant Extra	10	Picking	50 lbs/ac
Corn	0'-2'	10	5	30 bu.	15	Cultivation	10	Harvest	15 bu/ac
Wheat	2.1'-4'	10	10	15 bu.	10	Combines	10% longer to harvest	None	
Johnsongrass Meadow	2.1'-4'	5	15	1 ton	1	None	-	None	
Pasture	4.1'-6'	10	10		No damage				

Other Damage From this Flood

Type	Damage: Quantity	Damage: Value
Fence	4 rods	
Poultry	12 hens	
Livestock	1 heifer	

Equipment ______ None

Levees ______ None

*Scour ______ 5A/20%

*Bank Cutting ______

*Sediment ______ 5A/25%

Value of Cropland: $100 acre

Value of Pasture: $30 acre

Q. What changes in land use have been made due to floods? A. 10 acres of row crops to Johnsongrass meadow.

Q. What changes would be made if the frequency of flooding were reduced by half? A. All of meadow to crops and 5 acres of pasture to crops.

Q. How often do large floods occur? (If the flood described above is a large flood, change this question to small floods.) A. Once in 8 years.

Q. During what seasons are floods most common? A. Large floods: Spring - 1/2; Fall - 1/2. Small floods: Spring - 3/4; Fall - 1/4;

Q. In addition to the loss in yield described above, was there any damage to quality of crops? A. Wheat-weeds because wheat down. (Estimated percent. Docked price of wheat 25%.

Q. What damage did this flood do to roads and bridges nearby? A. Washed out approaches, about 10 loads needed.

*These items may be total damage since he has been on the farm.

Figure 3.7

Many farmers can give information about only one flood. This may be the most recent, the largest, or the most damaging he has experienced. However, information should be obtained on as many floods as possible. The enumerator should obtain as accurately as possible the proportion of cropland in the various crops. Although normal crop rotations will cause different crops to occupy a given field from year to year, the over-all distribution should reflect the situation in the flood plain. It can be expected that some cropland will be idle. The division of the flood plain among cropland, pasture, woodland and other uses in some cases can be determined by planimetering recent aerial photos of the flood plain.

The data thus obtained usually represents present land use and cropping patterns. Adjustments should be made where these data do not represent the expected future land use and cropping pattern without project. Evaluation of conditions as they may be affected by the project is described in Chapter 4.

Most of the information collected through farmer interviews should be in terms of physical quantities rather than values. Their monetary evaluation should be made in the office. Otherwise, much time will be used in trying to determine what items the farmer has included in his value estimate and the price base he has used.

Information on damages to non-agricultural property also may be obtained and recorded on appropriate flood damage schedules. Special schedules may be needed to record damages to residential, commercial, and industrial property as well as to highways, bridges, railroads and utilities. Figure 3.8 shows a sample schedule for residential flooding. If there are numerous residences subject to damage, a sampling procedure may be used. When there are considerable differences in the types or values of the affected residences, the sample should be stratified to reflect these differences. Commercial and industrial establishments are so varied in their equipment, inventory, and susceptibility to damage that a complete inventory is advisable in most small watersheds. Except for residential damage, most non-agricultural damage data will require less editing in the office than is needed for agricultural damage. Reasonably accurate records generally are used in industrial or commercial enterprises.

C. Analysis of Damage

Damage estimates are based upon information obtained in the field. This information constitutes the raw data which must be analyzed and processed before it can be correlated with data worked out by other specialists to obtain an accurate appraisal of the effects of the project.

The planning party is faced at all times with the problem of balancing scanty data with the cost and the time required to obtain and

FLOOD DAMAGE - RESIDENTIAL
(Sample)

Watershed ______________________ Reach ________

Location of property: Stream mile ______________ No. __________

Occupant ____________________________ Years Occupancy __________

Damaging floods: No. _______ Dates ______________________________

APPRAISAL OF DAMAGE

Property damaged	Experienced or Potential Floods 1/		
		Extent of damage	
Residence and contents			
(Depth of water in basement)			
(Depth of water on first floor)			
Foundation			
Basement and contents			
Floors and walls			
Furniture			
Personal belongings			
Lawn			
Garage (depth of water)			
Other buildings (depth of water)			
Automobiles (depth of water)			
Other losses			
Clean-up			

Relevant Data:

Type of residence: Frame _____ Masonry _____. Size of residence ____ square feet. Market value of residence $_______. Replacement value of furniture $_______. For experienced flood describe any emergency activity for prevention of losses or evacuation __________

1/ Indicate the date of experienced floods. Show height of other flood stages in terms of plus or minus depth increments referenced to the experienced flood.

Figure 3.8

analyze more complete information. It may be necessary to adopt certain assumptions and to develop short-cut procedures in order to obtain reasonably accurate answers with minimum planning costs. In so doing, it is important to remember that assumptions are not necessarily facts.

1. Crop and Pasture Damage

The floodwater damage that will be sustained by crops and pasture depends upon the damageable value of the crop, the seasonal occurrence and frequency of flooding, and the characteristics of the flooding such as depth, velocity of flow, sediment load and duration. The damage schedules can form the basis for estimating many of these factors.

The yield which would have been obtained in a watershed had there been no flooding is a hypothetical figure. Flood plains of creek watersheds are so small that accurate yield data from secondary sources seldom are available. Basic data on the yields to be expected in the flood plain can be obtained from the schedules, but these should be scrutinized rather carefully.

The data obtained from the schedules may be biased as many other things might have happened to reduce the yield had a flood not damaged or destroyed the crop. The reported yields should be adjusted in the light of knowledge of fertility, farming methods, etc., in the area. Excellent data on crop distribution and yields often may be obtained from ASCS offices. The degree of damage from scour and overbank deposition of sediment reported by the sedimentation party also should be considered.

The flood-free yield so determined may be adjusted further by consideration of the effect that improved technologies may have during the project life. Some agricultural colleges and experiment stations have developed estimates of the yield increases that can be expected from this source at various benchmark dates. Other estimates have been made as a part of river basin studies. An assumption often used is that the best practices now in use will be common within 15 or 20 years. Benchmark yield data from Work Unit Technical Guides may be useful. In estimating future flood-free yields without the project, consideration should be given to the degree to which the risk of flooding will inhibit the full use of improved techniques.

Percent damage factors are derived for each crop to relate the damage to the month or season and the depth or duration of flooding. An example of steps required in the estimation of the percent damage to a given crop at each depth increment of flooding during a given month or season is shown in table 3.3. Similar procedures can be used for other depths or duration of flooding and for other seasons or months. This procedure should be repeated for each of the crops in the flood plain.

The schedules that can be obtained in most watersheds will not furnish adequate information for determination of the percent damage factors for all months or seasons and perhaps for all depths or durations, because information usually can be obtained in a creek watershed on only a few floods. Damage information that previously has been obtained in similar areas may be used to supplement field data on a given watershed to indicate general relationships and to fill in gaps where the field data are inadequate. It is desirable, however, to calculate some basic percent damage factors for each watershed because of differences among watersheds in velocity of flow, soil detachability, topography or sediment load.

The major land use may be determined from the flood plain map. The present crop distribution in the flood plain can be obtained by adding the figures shown in the present acreage column from the schedules. Usually it is desirable to adopt the land use acreage at the year planning is begun to represent present conditions. If there are obvious reasons for making adjustments to reflect normal conditions more nearly, the acreages should be adjusted. A final adjustment will be the conversion of the existing use to that which can be expected in the future without project.

In some cases a uniform land use can be assumed in the flood plain. On other watersheds inspection of the flood plain may show a considerable difference in land use between upper and lower reaches of the stream. If this is the case, different land uses and damageable values should be used for the two (or more) reaches. Sometimes there may be significant variations in a given cross section in land use with elevation above the bankfull stage. The acreage inundated first may be woods or idle land in which there is little or no damage. If this is the case, it should be separated from the acreage damaged by flooding.

Table 3.4 shows a method of calculating the composite damageable value per acre of flood plain, when uniform land use is assumed.

The damageable value of each crop, determined as shown in table 3.4 can be multiplied by its percent damage factor and the products added to give the damage from flooding an average acre of flood plain to a given depth during each season. Table 3.4 illustrates a procedure.

The damage rates are multiplied by the acreages inundated for representative stages to develop crop damage curves, similar to that shown in figure 3.6. Development of damage curves for seasons rather than one for each month is adequate in most cases. This will substitute the development and reading of three or four curves for the twelve otherwise required.

Table 3.3 Flood Damage to Cotton, 3' and Over, Spring Flood, Village Creek.
(Sample)

Schedule No.	Acres Flooded	If No Flood				After Flooding				Gross Damage	Expenses Saved	Net Value Alternate Crop	Added Expenses	Net Damage
		Estimated Yield	Total Production	Price Per Unit	Total Value	Actual Yield	Total Production	Price Per Unit	Total Value					
	(1)	(2) (lbs)	(3) (lbs)	(4) $	(5) $	(6) (lbs)	(7) (lbs)	(8) $	(9) $	(10) $	(11) $	(12) $	(13) $	(14) $
72	40	300	12,000	0.386	4,632	0	0	0	0	4,632	1,782	916	0	1,934
121	10	135	1,350	0.386	521	0	0	0	0	521	162	0	0	359
114	8	250	2,000	0.386	772	133	1,064	0.386	411	361	112	0	10	259
Total	58	228(av)	15,350		5,925		1,064		411	5,514	2,056	916	10	2,552

Damage Per Acre Flooded $44.00

Percent damage 43

Procedure: Column (1) x Column (2) = Column (3). Column (3) x Column (4) = Column (5).
Column (1) x Column (6) = Column (7). Column (7) x Column (8) = Column (9).
Column (10) = Column (5) minus Column (9).
Column (14) = Column (10) plus Column (13) minus the sum of Columns (11) and (12).

Table 3.4- Composite Damageable Value Per Acre of Flood Plain
(Sample)

Crop Use	Percent in This Use	Unit	Yield Per Acre of Crop	Production Per Flood Plain Acre	Value Per Unit (Dollars)	Damageable Value (Dollars)
Corn	6.3	bu.	30	1.89	1.24	2.34
Cotton	6.3	lb.	183	11.5	0.386	4.44
Oats	10.5	bu.	33	3.46	0.81	2.80
Wheat	6.6	bu.	18	1.19	2.00	2.38
Hay, (J.G.)	0.3	tons	2.0	0.006	16.22	0.10
Pasture	67.0	A.U.M.	2.50	1.68	2.61	4.38
Misc.	3.0					

Table 3.5- Composite Crop and Pasture Damage Rate, per Acre Flooded, by Depth of Flooding, Spring Season (April, May and June)
(Sample)

Crop	Damageable Value Per Acre	Net Damage					
		Depth 0 - 1.0'		Depth 1.1' - 3.0'		Depth 3.1' and Over	
	(Dollars)	(Percent)	(Dollars)	(Percent)	(Dollars)	(Percent)	(Dollars)
Corn	2.34	26	0.61	35	0.82	47	1.10
Cotton	4.44	17	0.75	41	1.82	52	2.31
Oats	2.80	32	0.90	50	1.40	63	1.74
Wheat	2.38	33	0.76	50	1.19	63	1.48
Hay, (P.G.)	0.10	20	0.02	23	0.02	36	0.04
Pasture	4.38	10	0.44	18	0.79	20	0.88
Total			3.48		6.04		7.55

The above illustrates a procedure for watersheds where depth of inundation is more meaningful than duration of flooding. This is the situation on most watersheds. However, when water gathers on a wide, relatively flat flood plain it may remain for a considerable time. If this occurs duration may be the most important factor. Increments of duration may be handled in a manner similar to that illustrated for depth increments.

2. Other Agricultural Damage

The damage schedule should contain spaces for recording such other agricultural damage as livestock losses, damages to fences, farm equipment, farm levees, etc. It is suggested that the physical amount of such damage be recorded and monetary values be determined in the office. One reason is that if a farmer reports $100 damage to his fences from a flood in 1958, he may be thinking of what it cost him then, or he may have in mind what it would cost at today's prices. A second reason is that when a farmer gives damage in monetary terms, one needs to have a definite understanding of whether he means only out-of-pocket cash costs or such costs plus the value of unpaid family labor or a complete cost including interest and depreciation on farm equipment. Such monetary values are more difficult to pin down where fences, livestock, etc. are involved than if only crop values are concerned.

Seasonal curves for these other agricultural damages ordinarily will not be needed. Damages of this type may not start until a fair stage overbank is reached. As an example, floodwater probably will need to be at least two feet deep before there is much damage to fences. On the other hand, damage from infestation by noxious weeds may begin at a low flood stage. The sampling procedure used for estimation of crop and pasture damage will be applicable to estimates of damage of this type. Expansion of data from the sampled areas to the entire flood plain can be made safely if the sampling has been done correctly.

When irrigation, drainage, or farm levee systems exist in a watershed and are subject to flood damage, they should be given special consideration and evaluated separately. For example, the damage to an irrigation system might consist only of silting up the ditch or washing out a siphon but before repair of such damage could be made the inability to use the system might cause loss of a crop because of lack of water.

3. Nonagricultural Damage

Most of the damage in small watersheds may be to agricultural property, with a certain amount of damage to such transportation facilities as roads, bridges and railroads. In some areas, however, there will be damage to residential, commercial, and industrial property and to parks, schools and the like. Appraisal of these damages often will require special treatment. A random sample of the flood

plain cannot be drawn for this purpose, because the areas subject to damage are localized and the concentration of damage per unit of area is high. Appraisal will require specific consideration of each damage area in order that damages may be related to flood stages.

Complete enumeration of damages may be impractical in case a large urban area is flooded. In such an event, an adequate sample should be drawn from the flooded urban areas. Care should be taken that residential sampling represents important value groups of housing. Commercial establishments of the same type may be sufficiently similar in values and susceptibility to damage that samples of each type of establishment may be drawn. But, for example, furniture store damage should not be used to represent supermarket damage. The diversity in industrial plants is such that each usually must be evaluated separately.

When protection of an urban area is a principal project objective, a detailed map of the area subject to flooding should be prepared. Enough valley sections should be surveyed to enable the hydrologist to prepare flood flow lines that will show area flooded by the largest flood of record or the design flood both without and with the project. Such a map will be of use to the economist in evaluating flood damages and benefits from flood reduction.

The map will enable the economist to inventory the damageable value of the property in the flood plain. Upon receipt of information on the area and depth of flooding by floods of various sizes, the economist can coordinate his information into a depth-damage curve for the area.

Although duration of flooding may be a factor in the amount of crop damage sustained, it may have limited effect on many types of nonagricultural damage.

Consideration should be given to the probable future development of the flood plain in urban areas. The tax rolls showing trends in assessed valuation in flood plain may provide useful information. Real estate men usually are in a position to appraise past development and provide some information on existing trends. City officials, such as planning boards, city engineers, city councils, mayors, and city managers, may be excellent sources of information. Organizations, such as chambers of commerce, can be helpful. Some general guidelines for evaluation of future development are given in section IV, A, 2 of this chapter.

Other secondary sources of information such as files of local newspapers will be of value in fixing the limits of floods experienced in the past. They also may contain pictures of the flood

and property damaged. Their appraisals of damage will be useful if the flood is of fairly recent date. If the value of property has changed significantly since the date of occurrence of the flood, the estimate of experienced damage should be adjusted to reflect the new values. Effects of protective measures that have been installed since previous flooding should be examined. Further adjustments for future development and projected price levels will be needed.

a. Roads and Bridges

Estimates of road and bridge damage may be obtained from State highway engineers, boards of county commissioners, county engineers, or township trustees. These data should be related to specific events and depths of flooding. Many times, however, such information is incomplete. A county commissioner may be newly elected and unable to report on the expenditures of his predecessors. Or he may have a certain sum to spend and keep no particular records regarding the proportion spent for ordinary maintenance and that for repair of damage. Recorded damages to roads and bridges may be inaccurate because of delayed maintenance or repair. A road or highway district may have only a budgeted sum for repair or maintenance which may cause total costs to be spread over several years. For these reasons, the sample flood damage schedule carries the question "What damage did this flood do to roads and bridges nearby?" It is believed that this information obtained from farmers and others will provide a check on the data from other sources. Probably they will have little information on costs, but they can pinpoint the location of major bridge and road damage. Furthermore, in some areas, farmers cooperatively repair some of the roads and bridges. When this is the case, the full cost of repairs may not be found in the books of public officials.

When obtaining information on historical damage to roads and bridges, it is necessary to find out the condition of the facility at the time it was damaged. Increased modern traffic and flood hazards often cause replacements to be better and less subject to flood damage than the original facility. When this has occurred or if it seems likely to occur in the future, damage estimates should be based on the new facility.

b. Railroads

Information on damage from severe floods to railroad property usually can be obtained from railroad officials. Caution should be observed in obtaining this information to make sure that it is complete, particularly if only partial repair is made immediately after the flood and complete restoration is deferred. The question also arises, with railroad damage, as to whether or not there is segregation of normal maintenance and flood repair expenditures when less than major floods are concerned.

Ordinarily, it is desirable to obtain as much information as possible from local railroad officials to supplement that obtained from company headquarters. Local people usually can give information on the location of track and bridges damaged and an indication of physical damage. Such information can be correlated with published data and information previously gathered elsewhere.

c. Residential

Flood damages to residences and appurtenances may constitute a large portion of the total flood damage in some watersheds even though no major concentration of population exists and only a few scattered houses in the flood plain are affected. Where this is the situation, damages to residences should be appraised separately in each case by making inquiry of informed residents.

Flood damages to such properties usually include some or all of items as: house, garage, septic tank, lawn, shrubbery, vegetable garden, orchards, sidewalks, fences, and small animal shelters. Mobile equipment on the premises at the time of floods may also be damaged.

Some district offices of the U. S. Corps of Engineers have compiled schedules of average damages to dwellings and contents when flooded to different depths. A study by the Stanford Research Institute contains much useful information. These and similar compilations may be helpful in supplementing data from the field but they should never be relied upon without field investigation to determine if they are applicable.

A damage form or schedule may be prepared to serve as a guide and a check list in estimating losses. When appraising and recording damages it is important to associate the damage with depth of inundation in order that stage-damage relationships may be established. The schedule sample included herein (figure 3.8) indicates the kinds of information required. With some modification it may fit the needs of most watersheds where residential damages occur.

To comply with the need for development of a stage-damage relationship, damage appraisal for several different flood stages is required. The range in flood stage for damage appraisal should extend from the point where damage commences to a stage possibly one or two feet higher than the maximum flood on record. Usually the highest stage for which damages are estimated is that of the 100-year flood.

On streams where flooding of houses is quite frequent, precautions should be taken to determine, (1) if repairs are made following floods and before succeeding floods occur, and (2) if flooded parts of the house or appurtenances are utilized in the normal or

"flood-free" manner. When building values are not maintained and when basements, for example, are not utilized for normal purposes because of frequent flooding, account of these conditions should be taken in adjusting damage appraisals downward from the losses which would occur under normal conditions. As an offset, however, it may be possible that upon protection full use will be made of the property and the value enhanced.

4. Other Floodwater Damage

There may be flood damage of types other than those described here in an occasional watershed. If so, the damage should not be neglected, although special procedures for its evaluation may need to be devised. As an example, flooding may leave stagnant pools in depressions which become breeding places for mosquitoes. The cost of mosquito control, insofar as it stems from this source is a flood damage. Loss of life in the watershed during floods, although not evaluated in monetary terms, should be reported as an intangible damage.

5. Indirect Damage

Indirect damages include certain losses which result from flooding even though the property involved was not flooded. Some examples of such indirect damages follow. An electric power plant is flooded so that power is no longer produced and spoilage takes place in freezers and refrigerators operated by electricity. A bridge is washed out and traffic is forced to detour a considerable distance. A flood causes interruption in the feeding regimen of a livestock producer and, although his livestock were not in the flood, the upset slows down the rate of gain and causes extra expense before they are marketable.

In estimating indirect damage, care must be taken to avoid double counting. For example, a house may be flooded and the family living there may lose its clothing. This loss is a direct damage, but the value of substitute clothing supplied by a relief agency would not be an additional indirect damage.

Information on indirect damages usually is more difficult to obtain than on direct damage. Although some data will be gathered during the course of ordinary damage interviews, it seldom will be complete. Indirect damages are of so many different kinds that neither the economist nor the respondent may think of all possibilities. Experience has indicated that indirect damage often may be expressed as a percentage of the direct. The information from the schedules generally will be sufficient to indicate the portion of the suggested range that is applicable. Considerable latitude may be allowed for special cases. The following percentages of direct damages are suggested for use in estimating indirect damages.

Type of Direct Damage	Percentage Range
Agricultural 1/	5 - 10
Residential	10 - 15
Commercial and Industrial	15 - 20
Highways, Bridges and Railroads	15 - 25
Utilities	15 - 20

1/ The percentage probably will be much higher when irrigation and drainage facilities are damaged. The indirect damage should be determined on a case basis when these facilities are involved.

A special situation often exists in the case of residential housing. In many cities low cost housing tends to occupy the flood plain. When this is true, a special study of indirect damage is needed as the usual relationship between direct and indirect damage may not hold.

In an area exceptionally sensitive to flooding, evacuation may take place as soon as a flood threat arises. Then indirect damage would accrue even though no flooding actually occurred. When a residence is flooded, the direct damage curve generally flattens as greater depths of water are reached. In addition, the indirect damage usually becomes less in proportion to the direct.

IV. BENEFIT EVALUATION

Thus far in this chapter the principles of damage appraisals have been presented and basic appraisal methods have been described. Damage appraisal usually is essential in flood prevention in order that benefits for economic justification may be determined. The determination of flood prevention benefits is described briefly in this section of the chapter.

A. Off-Site Benefits

In general, off-site benefits may be considered as accruing to someone who has no control over the source of damage. In the case of a critical sediment producing area, off-site benefits may result from control of the sediment output in the form of a decrease in rate of channel filling and the resulting flooding downstream. A floodwater retarding structure will create off-site benefits from reduced

flooding on the downstream flood plain. Off-site benefits usually are the principal type of benefit to be derived from flood prevention measures.

1. Reductions in Damage

Flood damages are reduced by a reduction of discharge or an increased channel capacity, which in turn reduces the area, duration, and depth of flooding or the sediment load carried for downstream deposition. Evaluation requires the determination of the damages under non-project conditions and those remaining after land treatment and successive increments of structural measures. The difference between the damage before and after installation of any segment of the project constitutes the benefit from damage reduction creditable to that segment.

In addition to reductions in ordinary physical damage, consideration should be given to the possibility that flood prevention measures sometimes will reduce the cost of operation and maintenance or lengthen the life of proposed or existing facilities. For example, a heavy sediment load in a stream may cause such extensive channel filling that it requires cleaning out at frequent intervals. In this case, benefits could arise from reduction in the cost of cleaning out the channel and would constitute a form of damage reduction benefits.

In the Frequency Method the modified discharge-frequency curve, prepared by the hydrologist, will enable the economist to prepare a modified damage-frequency curve to compare with the non-project or original damage-frequency curve to determine benefits. Modified curves prepared by the economist and hydrologist are necessary for each kind or combination of measures being evaluated.

The same principle is involved in the Historical Series Method. The total difference in damages over the evaluation period, adjusted for recurrence, is divided by the number of years in the series to determine average annual damages. This is required for each kind or combination of measures being evaluated for comparison with the non-project or original damage.

Benefits from reduction in damage as a result of flood prevention measures generally begin to accrue as soon as the measures are installed and need no discounting for time lag. The chief exceptions will be when areas are restored to their former productivity. If there is land damage from sediment deposition or flood plain scour, time will be required for recovery. Likewise, if frequent flooding has caused a shift to land use less susceptible to flood damage, operators of flood plain lands can be expected to wait until they can judge the effectiveness of their protection before they restore the area to its former use. Proper discounting should be considered for such benefits when significant time lags are involved.

When reduction in land damage is used as a benefit, appropriate adjustments in estimates of other types of damage should be made.

As an example, when flood plain land is destroyed through stream bank erosion, the estimate of crop and pasture damage during the life of the project must be reduced to take into account the progressively smaller area that will remain to sustain damage.

A technical problem that arises in the evaluation of the benefits from waterflow control measures is the collaboration between the hydrologist and the economist in determining the acreages involved. The flood routing to determine damages under non-project conditions and after land treatment measures have been installed may be done before floodwater retarding structure sites have been determined. When these sites have been located finally, it may be that part of the flood plain on which previous routing has been made will be included within the pool area of the structure. Unless adjustments are made, the difference between damages before and after project installation would include the damage within the pool area as a project benefit. Adjustments of a similar nature also will be needed when channel improvement or floodways are planned and their benefits are evaluated.

2. Future Development in the Absence of a Project

As discussed earlier in this chapter, project evaluation requires a comparison of conditions which would exist over the project life in the absence of the project with those that can be expected with the project in operation. In nearly every project, therefore, the damageable value base from which evaluation is to be made will be different from the present situation.

The most common approach to this problem is to estimate the eventual degree of change, the period over which the change will occur, and assume that the change will take place uniformly over time. This will provide an annual increment of change which can be discounted to present worth and used to adjust the present to average future conditions.

It is worth noting that the use of a simple average of the existing and eventual values for this purpose is unsound because deferred values are worth less than similar values at hand. Consequently, when damageable values are increasing, the greatest value will be at the end of the time period and will receive the heaviest discount. The average annual equivalent values after discounting, then will be less than the simple average of values. The reverse is true if damageable values are declining. (For a more complete discussion, see Appendix A).

In an expanding economy it can be expected that values generally will increase. Improving technology and the pressure from increasing population will encourage increased agricultural production per unit of area. Values in existing developments will increase because of new products and a higher standard of living. Urbanization will cause urban areas and the suburban fringes to encroach upon areas now in agriculture. Although this will be the usual situation, there will be cases where values will decline. Changes in diet and cost-price

relationships may encourage shifts of some areas from cash crop to livestock production. Small rural communities may decline in importance as improved travel makes larger centers more accessible. Consequently adjustments to account for future development may involve either increases or declines in damageable values.

Changes in development without a project should not be confused with the enhancement-type benefits caused by the project, described in Chapter 4.

3. Increased Income

The flood hazard often prevents the highest use of resources. Once the hazard is removed, these resources probably will be used more effectively. For example, a flood plain pasture is little used because of the hazard to livestock. So-called "catch crops" are being grown instead of high value crops in an effort to avoid the season of worst flooding. These are examples of situations where protection may allow land to remain in its original use but income will be increased through more effective use of resources.

Protection also may allow land to be converted to higher, more productive uses. Perhaps brush will be cleared and a frequently flooded field will be converted to cropland after effective protection. Or unused land in an urban area will be shifted to industrial or other use.

Changes of these types usually will take place only after some lag in time. Benefits calculated therefrom should be discounted accordingly.

The increased net income resulting from such changes is a benefit derived from flood prevention. Associated costs required to make such changes possible should be deducted from the gross increase in income.

Special consideration should be given to certain situations in evaluating enhancement-type benefits. Included among these are the following:

a. Sometimes flood plain production will be increased through moving crops from upland areas less suited to their production down to the fertile flood plain. The upland area is shifted to a less intensive use. When this is done, the increased income from the flood plain may be offset partially by reduced income in the upland area.

b. In an urban area there may be expansion of industry, business, or residential developments into the flood plain after protection. Had there been no protection, the total expansion might have been about the same but it would have been into other areas, perhaps the agricultural fringe around the city. Here the enhancement benefit would be only from the advantage the flood plain would have over the alternative areas in such things as economy of development or use.

c. Special care must be taken to distinguish between enhancement resulting from the project and future development that will take place without the project, because of the possibility of double counting. Often a separation by geographical areas where only one or the other is anticipated will be helpful. Evaluation of these enhancement-type benefits is discussed in some detail in Chapter 4.

4. Remaining Damage to Higher Values

An attempt to provide complete flood protection ordinarily will not be economic. It may even be physically impossible. If the project is installed and the flood plain is used more intensively as a result, it can be expected that remaining floods will cause more damage than they would under the original land use. The increased income from restoration, intensification or changed land use should be adjusted to account for this condition.

Adjustments may be made either for the frequency or the historical methods by using the new damageable values and the flooding from the remaining events. Experience will indicate appropriate shortcuts that can be used to fit a given situation.

B. On-site Benefits

On-site benefits are those that accrue at the general location of the control measure.

Many land stabilization measures produce on-site as well as off-site benefits. Vegetative plantings on critical sediment source areas may increase the net return from cropping, grazing, or wildlife production. Stabilization may preserve the full value of land that otherwise would be encroached upon by gullies. Sometimes installation of land treatment measures would not be feasible without first installing measures for stabilizing gullies. Increased net returns that occur on the drainage area of the structures over the amount that could be obtained without structural stabilization measures are creditable to the structural measures. Such benefits may be largely in the form of reduced crop or livestock income losses or increased crop or livestock returns. Details of the evaluation of land damage from erosion and sediment deposition may be found in Chapter 5. The cost of the necessary land treatment measures, when their installation is made possible because of the stabilization measures, should be handled as an associated cost.

Such waterflow control measures as detention-type terraces and water-spreading devices may give important on-site benefits. These benefits may be measured through an approach similar to that described above for land stabilization measures.

On-site benefits may be available within the site of a floodwater retarding structure. Such benefits may accrue from fish culture,

recreation, and use of the sediment pool for stockwater, irrigation or domestic water supply. Evaluation of the benefits from other uses should take into account the fact that the sediment pool is designed to store sediment and its ability to furnish incidental benefit will decline through the project life. Any benefits claimed should be discounted on this account. Evaluation of benefits when used incidentally for irrigation should recognize the fact that the sediment pool cannot be expected to furnish a fully dependable water supply for this purpose. Evaluation of on-site benefits from incidental use of floodwater retarding structures should take cognizance of State laws regarding water use. For example, in some states prior appropriation has been made for certain downstream uses and provision has to be made for drainage of the sediment pool on demand. Under these conditions no firm on-site benefits can be claimed for its use.

V. COSTS

Economic analysis involves the comparison of the costs of a project with the benefits which it produces. Both are reduced to equivalent time values. This may be done either by capitalization of periodic benefits and costs to place them on the same basis as capital outlays, or by converting capital sums to their annual equivalent through amortization. The latter is the usual procedure.

Costs may be divided into two main groups - project costs and associated costs.

A. Project Costs

These costs include all costs incurred in project installation, operation and maintenance which are to be compared with project benefits.

1. Installation Costs

Included in the project installation costs are all costs of construction, including design, engineering, inspection and an allowance for contingency. The value of lands, easements, rights-of-way, and the cost of relocating facilities that must be moved because of the installation are included.

At times sites may be purchased. In this case the funds expended are a measure of the cost. In other cases, the estimate of value by the local organization, with the concurrence of the Service, will be used for determining the value of the site. Even when sites are donated, there usually is a cost to someone although this may be offset in whole or in part by incidental benefits from the new use of the site. Some of the considerations inherent in site cost evaluation are discussed in Chapter 13, Land, Easements, and Rights-of-Way.

Installation costs are capital expenditures incurred during project installation. As such, unless there is a prolonged installation

period, current price levels should be used. In case any one structure in a project will require a prolonged period (over two years) for its installation, interest on the average investment during this period becomes a part of the installation cost. Ordinarily this will not be applicable to small watershed projects. For comparison with project benefits, installation costs are amortized over the project life. Although not usually applicable to flood prevention projects, if salvage values remain after the end of the project life appropriate deductions in costs may be considered.

2. Operation and Maintenance Costs

The cost of maintaining works of improvement in such a condition that they will deliver the full benefit for which they were designed is another cost component. Maintenance costs may vary from year to year, however, in economic appraisal the best estimate that can be made of average costs over the period of analysis should be used. Normally, the longer the project life, the more should be allowed for project maintenance.

Sometimes a project will have facilities which must be replaced during the life of the project. The original cost of such facilities will be included in the project installation cost and amortized over the project life. Provision for replacement will be made by inclusion of sufficient funds for this purpose in the maintenance cost of the project.

Another item of annual cost is operation of the works of improvement. When automatically operating measures, such as drop inlets or floodwater retarding structures, are concerned operating costs are generally nil. Such costs should be considered when manually operated gates and similar types of equipment are involved.

3. Induced Costs

These costs include all uncompensated adverse effects in goods and services caused by the construction or operation of a project.

A typical example would be the value of the loss in production on lands taken for project purposes that is in excess of the payment therefor or the estimated easement value. Thus if the estimated amortized easement value is $5,000 but the loss in agricultural production is $6,000 annually, the difference, $1,000 annually, is another economic cost of the project and should be included with project costs.

In calculating the loss of net income in agricultural areas to be used for project purposes, items to consider include: non-project land uses and yields compared with those attained with the project, flood damage to non-project uses, and taxes and overhead costs. Among the types of measures where these items may be significant are: fencing and exclusion of use in critical sediment source areas; the pools, embankment, and spillway of floodwater retarding structures; the channel and spoil disposal areas for channel improvement, etc.

It is not likely that flood prevention measures normally will be so located that they will displace production from industrial, mining or urban areas. If they are so located, adequate accounting should be made of the production lost.

If channel improvement or other similar waterflow control measures are terminated at a point where possible floodwater, sediment or erosion damages may be induced downstream, such damages should be considered as induced by the project. Sometimes flowage easements may provide a financial measure of these costs. If such costs are not adequate, the excess would be a form of "Other Economic Costs" of the project.

In some cases project installation may induce damage to fish and wildlife resources.

Whenever induced damages are caused, either measures should be incorporated into the project to alleviate these damages, or they should be counted as a tangible or intangible cost of the project.

B. Associated Costs

Associated costs may be considered as the value of goods and services needed over and above project costs to make the immediate products of the project available for use or sale. They are usually considered as deductions from benefits.

In flood prevention, associated costs are involved chiefly in calculating benefits from changed land use. Associated costs connected with changed use of the land, such as provision of streets and utilities in urban areas, or conversion from pasture to cropland, clearing woods, farm drainage and the like on agricultural land, are amortized and deducted from the increased income. It is possible that additional barns, granaries and equipment may be needed to handle the additional production. Thus associated costs may include an item for increased taxes and overhead. The increase in the cost of farm operations involved in crop production forms another item of associated costs for deduction from the increase in gross income.

When land treatment measures are required to realize the benefits from structural measures, the cost of the necessary land treatment becomes an associated cost. Such a case might arise if flood protection enables a farmer to level his land and install on-farm drainage or irrigation. Here land leveling and the on-farm drainage or irrigation systems would become associated costs.

The treatment of the direct costs of crop production is a little different in damage analysis. When a crop is destroyed by a flood, the full cost of operations yet to be performed is subtracted from the damage as expense not incurred. If the crop is flooded early and replanting is necessary, the full cost of the added operations is

included in the damage estimate. The term "full cost" includes the value of unpaid family labor and interest and depreciation on machinery as well as out-of-pocket cash costs.

Although associated costs do not appear in the benefit-cost ratio, their careful appraisal is most important. Because they are deducted from the gross benefit, they determine the size of the benefit used in economic analysis. They have almost equal importance as a supplementary economic tool in determining whether appraisals of damage and benefits are realistic. For example, the spread between gross income and associated costs is of high importance in estimating the amount of damage a farmer will take before letting his flood plain lands lie idle, and the degree of protection he will require before he intensifies his land use.

CHAPTER 4

EVALUATION OF RESTORATION OF FORMER PRODUCTIVITY, CHANGED LAND USE AND MORE INTENSIVE USE OF BENEFITED LAND

This chapter deals specifically with evaluation of enhancement-type benefits, including restoration of former productivity, changed land use, and more intensive use of benefited areas. It illustrates some of the major types of problems that are likely to be encountered in evaluating these items. It outlines some considerations in projections of crops under acreage allotments and marketing quotas. The discussion herein is applicable to projects for flood prevention and agricultural water management. The basic principles also may be applied in considering benefits from recreation and fish and wildlife and secondary benefits.

I. GENERAL

A. Agricultural Benefits

Many areas of flood plain land were once in cultivation or pasture but now are abandoned or in low income-producing uses because of adverse effects of flooding. The reduced income from such a condition may be considered a type of flood damage. One farmer may take his field out of cultivation because of this hazard while his neighbor, although experiencing the same severity of flooding, is continuing his attempt to cultivate and is experiencing heavy flood losses. Installation of flood prevention measures reduces the flood hazard sufficiently to induce the first farmer to restore his flood plain to a use consistent with its former productivity while the second farmer finds his flood losses reduced. The difference in the net income received by the first farmer between that which he now is receiving and that which can be expected under the restored condition, is a benefit from "restoration of former productivity". It can be seen that such benefits, although they may be evaluated much the same as a true enhancement benefit, are allied conceptually with benefits from damage reduction. For this reason they usually are reported as damage reduction benefits.

Benefits from restoration of former productivity should not be confused with those obtained from changing the use of land that has never been in cultivation, but which may be put into cultivation as a result of the project. For example, if land that has always been in woods, pasture or wild land, is converted to cropland as a result of the project, the benefits resulting would be classed as derived from "changed land use". Ordinarily there are policy restrictions on the extent to which these benefits may be used for project justification. Such restrictions usually apply to putting new land into production in the case of agricultural water management, and to increasing the acreages of certain crops.

Another type of benefit that may result, is an intensification of present use. The flood hazard may deter the operator from using the land

as intensively as he would if there were no flooding. For example, if the flooding were reduced so the added investment were profitable, he might shift land presently in small grain to alfalfa. Or he might use fertilizer and seed to improve low producing pasture. This type of benefit may be predominant in drainage and irrigation projects. The intensity of use in similar nearby watersheds where flooding, wet lands, or lack of water are not problems may be used to guide the estimate of intensity of use when these hazards are removed in the watersheds under consideration. Benefits of this type are classified as benefits from "more intensive use".

B. Non-agricultural Benefits

Enhancement-type benefits may accrue to the non-agricultural community as a result of a project. Primary benefits of this type are likely to come from measures for flood prevention although there may be enhancement-type benefits from nearly any type project.

Flood protection may permit business, industrial, or residential development of flood plain areas where there is risk of flooding without protection. Such areas often are level and can be developed much cheaper than nearby uplands. The development may take the form of a shift from agricultural to rural residences, suburban or urban use. It may involve development of idle land or land in a low order of use within urban limits.

The preferred method of evaluating benefits of this type is through the annual equivalent of the increased value of the land. If data are not available, an alternative method is the increase in the net rental income from the land. These approaches apply when industrial, commercial or residential development is concerned. In most instances there would be an opportunity for the same type of development elsewhere. If benefits are claimed for the project, the development in the benefited area should have advantages over outside development in terms of higher income, lower development costs, or both. Only the difference between the project and other development net values after development costs are deducted can be considered a project benefit.

A variant of this situation may occur when the project permits development of the benefited area for public use. Perhaps a highway can be constructed along a flood plain much cheaper than through the upland. The saving in cost would be the benefit. Sometimes the protected area may be converted into a park. Here the benefit may be measured in the form of an apportunity cost or as a direct recreational benefit. The opportunity cost approach would involve measurement of values foregone in some other use if the park development were located elsewhere, assuming approximately equal park facilities. Sometimes the protected area will possess unique advantages for recreation and the benefits can be measured directly. Evaluation of recreational benefits is discussed more fully in chapter 9.

Because of the high investment and the concentration of people involved in non-agricultural developments a higher degree of protection can be justified than for the typical agricultural project.

II. BASIC DATA NECESSARY FOR EVALUATION

Evaluation of benefits of the types described in this chapter is complex and requires a thorough study of the individual watershed.

Identification of the areas on which these benefits may accrue is essential. Several physical, social and economic factors govern the amount of change, restoration or intensification that will result and when the expected change will occur. Information on at least the following factors should be obtained and evaluated.

1. Potential of the land.
2. Type of farming.
3. Width and topography of the flood plain or area to be benefited.
4. Need for various types of production, whether in agricultural products or in urban and industrial services as the case may be.
5. Degree of protection or service afforded by the improvements.
6. The change supported by this degree of protection or service.
7. Willingness, intentions, financial and managerial ability of present and future operators to develop the land.
8. Availability of markets for any new products.
9. Restrictions imposed by acreage allotments, marketing quotas or zoning regulations.

For agricultural purposes the productivity of the land and its responsiveness to production inputs such as fertilization, irrigation, or drainage are highly important. If non-agricultural uses are being considered, such things as drainage, accessibility to transportation, stability as a building site, and cost of correcting any adverse conditions must be determined.

Increased mechanization enhances the desirability of relatively large, level fields for agricultural production. The same characteristics favor large scale urban development. Hence, other things being equal, a relatively broad and level flood plain is likely to reach a higher stage of development than one which is narrow and uneven.

It may not be physically or economically feasible for a project to meet all of the potential needs of the watershed. For example, an irrigation project probably will not supply full water requirements 100 percent of the time. Correct evaluation requires that sufficient information be obtained and analyzed to determine the proportion of needs that will be met, the production inputs that will be applied under these conditions, and the production that can be expected.

The intentions of present operators do not necessarily indicate the extent of future enhancement. They are helpful, however, in determining the delay to be expected in reaching the full level of benefits.

In order to claim "restoration of productivity" as a benefit, assurance should be had that (1) the land was formerly used for crop or pasture production, (2) that the change from its former use resulted from flooding and (3) that the reduction in flooding will be effective in permitting restoration to its former use.

The benefit calculation should be based on the effect of the measures in reducing or eliminating the existing restrictions on higher use. For example, determination of the area subject to development after flood protection will involve estimating the area flooded in each evaluation reach with and without the improvement being evaluated. The relationship of flooding to land use will be indicated by the use to which it is now being put under various conditions of flooding. That is, if land flooded one year in three is used for pasture at present, it and similar land likely will be used for pasture in the future if flooded at the same frequency. If, however, the frequency is reduced to one year in five, the land now in pasture may be converted to crops.

Calculations of net returns without and with project should take into account flood damages with the project as well as the cost of conditioning or developing the land for a change in use. The net return with the project is reduced by deducting the additional damage from the remaining floods to the higher values.

In those instances where there is a lag in attaining the maximum benefit, appropriate discounting procedures should be used. For example, when irrigation improvements are installed, farmers probably will need to experiment for a few years to learn amounts and times of water and fertilizer application to get optimum results.

III. CONSTRAINTS IN BENEFITS FROM ALLOTMENT CROPS

Certain crops are under acreage allotments or marketing quotas because otherwise production would be in excess of current or foreseeable needs. Others may be in surplus supply, although not restricted by allotments. Extreme caution should be exercised in claiming benefits from increasing the acreages of these crops as a result of project installation. This applies to all benefits of the enhancement-type described in this chapter.

As the population increases, some increase in the production of these crops will be needed, but much of the increase may result from improved technology. Consequently estimates of acreage increases should be restricted severely and should be assumed to accrue gradually over time. If such increases are evaluated, it should be assumed that they progress uniformly over the evaluation period. The benefits should be discounted accordingly.

Furthermore, if it is assumed that such increases will come about primarily through population pressures or increased world-wide economic well-being, it follows that the major effect of a project may be only to change the location of the acreage increase. For example, project protection may cause the increase in a given area to be wholly in the flood plain instead of in both the flood plain and the upland. Here the credit to the project would be limited to the increase in net returns from acreage only in the flood plain over those obtainable if the acreage increases were distributed over both flood plain and upland.

The foregoing applies to cases where it can be expected that the total acreage of the restricted crop will increase. In many cases the favorable project conditions will encourage only a shift of the crop to the benefited

area without increasing the total acreage in the watershed. Then the increased return in the benefited area may be offset partially by a decline in the return in the area from whence the crop was shifted.

In summary, it is essential that benefits from increased acreages of allotment crops be considered conservatively. It is necessary that only project-induced changes be considered. Only the net effect, after allowance for reduced returns elsewhere in the watershed, can be claimed. Finally, whenever these benefits are claimed, appropriate discounting is required.

All of the pertinent factors should be considered before estimating an increase in allotment crops in the flood plain. Neighboring watersheds where flooding, drainage, or an inadequate water supply is not a problem may indicate the relationship of benefited area to other land use for the allotted crops under consideration.

IV. BENEFITS FROM RESTORATION TO FORMER PRODUCTIVITY

In Evaluation Reach X, with a flood plain area of 1,600 acres, flooding has resulted in a considerable amount of cropland being left idle or converted to lower value use. Analysis of land use and production, through enterprise budgets, gives the data Without Project shown in table 4.1.

Table 4.1
Evaluation Reach X - Without Project (Sample)

Land Use	Acres	Flood-free Yield 1/	Gross Value of Production	Production Cost	Net Return
Corn	100	40 bu.	$5,560	$2,400	$3,160
Cotton	100	300 lbs.	9,000	7,230	1,770
Oats	100	40 bu.	3,280	1,600	1,680
Idle	200	-	-	-	-
Pasture	500	$4	2,000	500	1,500
Woods	500	$1	500	250	250
Misc.	100	-	-	-	-
Total	1,600		20,340	11,980	8,360

1/ As projected over evaluation period.

Analysis of information from schedules and other sources and consideration of the protection afforded by the project indicates the former use of the area shown in table 4.2 will be achieved approximately 5 years after project installation.

Table 4.2

Evaluation Reach X - After Restoration of Former Productivity With Project

Land Use	Acres	Flood-free Yield 1/	Gross Value Of Production	Production Cost	Net Return	Difference in Net Return
Corn	270	40 bu.	$ 15,012	$ 6,480	$ 8,532	$ 5,372
Cotton 2/	150	300 lbs.	13,500	10,845	2,655	885
Oats	150	40 bu.	4,920	2,400	2,520	840
Idle	80	-	-	-	-	-
Pasture	400	$4	1,600	400	1,200	- 300
Woods	450	$1	450	225	225	- 25
Miscellaneous	100	-	-	-	-	-
Total	1,600		$ 35,482	$ 20,350	$ 15,132	$ 6,772

Increased Net Return (Gross Benefit)	$6,772
Less Added Flood Damage to Higher Values	150
Less Development Cost (Associated Cost)	650
Less Loss in Upland Production of Cotton	500
Unadjusted Increased Net Return	5,472
Adjusted for Lag in Accrual (Net Benefit) 3/	5,144

1/ As projected over evaluation period.
2/ Assuming that 50 acres has been transferred from upland to flood plain.
3/ Assuming 100-year evaluation, 3 percent interest, 5-year lag, factor 0.940.

Table 4.2 is designed to illustrate several points in the analysis. (1) Under all conditions there probably will be miscellaneous land, farm roads and the like. In fact, as the intensity of use increases, the area in miscellaneous use may increase because of added needs for roads, build ings and other requirements. (2) When crops are moved from the upland to the flood plain, there is likely to be reduced production and net income in the upland. This should be considered. The $500 that has been deducted from the gross benefit to account for the shift of cotton could have been added to the production cost of cotton. (3) In almost all cases with flood prevention, there will be some added damage. In this case it has been assumed to be one percent of the increase in gross value of production. (4) Shifts in production can be expected to be greater for those uses where the investment, as in land clearing, is less. In this example, the greatest shift was out of idle, followed in order by pasture and woods as the costs progressively increase.

V. EVALUATION OF CHANGED LAND USE FROM LOW TO HIGH AGRICULTURAL USE

The degree of control provided in the assumed case will make it possible for operators to change the use of the benefited area beyond the point where the original use is restored. In table 4.3 it has been assumed that after the 5-year period shown for restoration, farmers have found that it would be profitable to go still farther in cropping the flood plain. Hence they have cleared additional woods and invested heavily in production of alfalfa. They have also replaced part of the native pasture with tame varieties. Some increase in farm roads is shown.

The "difference in net return" column in table 4.3 shows the difference between the "net return" columns of tables 4.3 and 4.2. Costs of establishment of alfalfa and improved pasture are included in the production cost of these crops. These costs have been amortized over the live of the stand at the interest rate the farmers would have to pay. The assumed damage from remaining flooding has been increased to 1.5 percent of the increased gross value of production.

The discount factors used in tables 4.2 and 4.3 were developed in the same manner as is shown in Appendix A, IV, B, except that an evaluation period of 100 years was used. In table 4.3 the build-up period is for 10 years. The period of level annuities is for the last 90 years of the evaluation period and requires discounting for 10 years. Thereby the factor of 0.872 is derived.

In cases where levees, floodways and the like constitute a part of the works of improvement, the lands taken out of production because of these improvements need to be considered in the evaluation. This can be done by showing an increase in the acreage of miscellaneous use with project.

VI. EVALUATION OF BENEFITS FROM MORE INTENSIVE USE OF CROPLAND

In tables 4.2 and 4.3 no increases in yield have been assumed to result from flood protection. In some cases removal of the flood hazard may

Tabel 4.3

Evaluation Reach X - After Land Use Change With Project (Sample)

Land Use	Acres	Flood-Free Yield 1/	Gross Value of Production	Production Cost	Net Return	Difference in Net Return
Corn	300	40 bu.	$ 16,680	$ 7,200	$ 9,480	$ 948
Cotton	150	300 lbs.	13,500	10,845	2,655	0
Oats	100	40 bu.	3,280	1,600	1,680	-840
Alfalfa	300	3 T.	24,570	11,775 2/	12,795	2,795
Idle	50	-	-	-	-	-
Improved Pasture	200	$20	4,000	2,400 2/	1,600	1,600
Pasture	200	$ 4	800	200	600	-600
Woods	190	$ 1	190	95	95	-130
Misc.	110	-	-	-	-	-
Total	1,600		63,020	34,115	28,905	13,773

Increased Net Return (Gross Benefit)	$13,773
Less Added Flood Damage to Higher Values	410
Less Development Cost (Associated Cost) 3/	1,350
Unadjusted Increased Net Return	$12,013
Adjusted for Lag in Accrual (Net Benefit)4/	10,476

1/ As projected over evaluation period.
2/ Includes cost of establishment amortized over life of stand.
3/ Includes added taxes and overhead costs.
4/ Assuming 100-year evaluation, 3 percent interest, 10-year lag factor .872.

permit increases in yields merely by allowing farmers to perform operations in a more timely manner. A frequent case is when farmers delay planting in order to avoid spring flooding. Even in flood-free years the yield is reduced below that which would have been expected had they been able to plant at normal times. After they have been given protection, they may reap increased yields by following normal practices.

In other cases, the protection will induce farmers to increase their production inputs markedly. After flood protection, they may develop on-farm drainage systems, fertilize heavily, or perhaps practice supplementary irrigation. Benefits from this source usually are classed as being derived from more intensive use of the benefited land.

This type of benefit is most applicable where drainage or irrigation is involved. Restrictions on bringing new land into production limit the amount of land use change that can be expected. Thus the major share of benefits will be derived from intensification of the use projected under non-project conditions.

Table 4.4 illustrates the evaluation on the assumed Evaluation Reach X, if after reaching the stage of development shown in table 4.3 farmers decided that non-project irrigation would be profitable, and developed and installed irrigation systems.

It is assumed that this development takes place during years 11 through 20 and yields become stabilized after the twentieth year. The damage from remaining floods is assumed to be 2.5 percent of the increase in gross production. A notable factor here is the increase assumed for production costs. For example, the added labor in irrigating, increased cultivation and harvesting costs, and heavier inputs of fertilizer, etc., have increased the production cost of alfalfa from $39.25 per acre (table 4.3) to $88.30.

From tables 4.2 through 4.4 the average annual benefits from restoration of former productivity, changed land use, and more intensive use of land accruing to Evaluation Reach X may be summarized:

1. Average annual benefit from restoration of former productivity (table 4.2)	$ 5,144
2. Average annual benefit from changed land use (table 4.3)	10,476
3. Average annual benefit from more intensive use of agricultural land (table 4.4)	12,543
Total	28,163

Other approaches could be developed. The arrangement presented here illustrates the need to keep the benefits of various types separate to insure that there will be no duplication of benefits. It also shows the

Table 4.4

Evaluation Reach X - After More Intensive Use of Land with Project (Sample)

Land Use	Acres	Flood-free yield 1/	Gross Value of Production	Production Cost	Net Return	Difference in Net Return
Corn - Irrigated	295	70 bu.	$ 28,704	$ 11,800	$ 16,904	$ 7,424
Cotton - Irrigated	145	750 lbs.	32,625	18,342	14,283	11,628
Oats - Dryland	100	40 bu.	3,280	1,600	1,680	0
Alfalfa - Irrigated	295	6 T.	48,321	26,051	22,270	9,475
Idle	50	-	-	-	-	-
Improved Pasture	200	$20	4,000	2,400	1,600	0
Pasture	200	$ 4	800	200	600	0
Woods	190	$ 1	190	95	95	0
Miscellaneous	125 2/	-	-	-	-	-
Total	1,600		$117,920	$ 60,488	$ 57,432	$28,527

Increased Net Return (Gross Benefit)	$28,527
Less Added Damage to Higher Values	1,275
Less Development Cost (Associated Cost) 3/	7,500
Unadjusted Increased Net Return	$19,752
Adjusted for Lag in Accrual (Net Benefit) 4/	$12,543

1/ Eventual yield after full development period.
2/ Allows for area in irrigation and drainage ditches and roads.
3/ Installation amortized over facility life plus operation and maintenance. Includes added taxes and other overhead.
4/ Assuming 100-year evaluation period, 3 percent interest, increase between years 10 and 20, factor .635.

probability that different types of benefits may accrue at different times and therefore will need to be discounted at different rates. Adjustments for development and other associated costs are accounted for.

VII. BENEFITS OF CHANGED USE FROM AGRICULTURAL TO NON-AGRICULTURAL OR MORE INTENSIVE USE OF NON-AGRICULTURAL PROTERTY

As described in Section IB, changed land use is not limited to agricultural use. Sometimes there may be project-induced or project-accelerated changes from agricultural to non-agricultural land as when rural residences are established, or cities expand into agricultural areas. At other times more intensive use is made of urban property as a result of the project.

Evaluation of benefits from such developments requires a careful appraisal of the existing situation, past trends, and future potential. A topographic map of the area under consideration is needed. This should show as a minimum the area that would be flooded by a one percent chance storm without the project and after project installation. Except for low damage use, such as parks, most non-agricultural developments should not be considered within the area flooded after project installation by the once in 100-year flood.

Information which is pertinent to appraisal of an area considered for development includes:

(1) Recent population trends,
(2) Population projections for the general area,
(3) Water supply,
(4) Topography of the area,
(5) Opportunities for new industries,
(6) Relative desirability of other areas for development.

Sources of information on potential non-agricultural development may be:

(1) Urban or county planning boards or commissions,
(2) Real estate associations and developers,
(3) Chambers of Commerce,
(4) Industries in the area,
(5) Retail business associations,
(6) Utility companies.

Frequently most complete and reliable information can be obtained from planning boards when they have made plans for development of an area in which the flood plain is included.

Because of the many variables as to types and rates of development that may take place, a careful analysis of all the information available is required in estimating benefits from non-agricultural land use changes.

If it is decided that development will take place in the protected area, the next determination is whether the project will cause the development, or merely cause a shift of development from another location.

In many cases the latter will be the case.

When there is a project-induced shift to the protected area, the project can be credited only with the advantage of this area over its alternatives. Such advantages may be measured in terms of increased values and reduced costs. In residential developments there are many factors having a bearing on desirability for home sites that usually are not considered subject to normal monetary evaluation. An example is convenience to schools and churches. However, these factors eventually find monetary expression in terms of what the prospective homeowner is willing to pay.

Principles underlying the evaluation of benefits when flood protection permits urban development of a flood plain in lieu of a less desirable alternative area are illustrated in the following example.

Protection given Evaluation Reach Y will permit development of 200 acres of residential use in place of the most favorable alternative of 200 acres of area Z outside the city. No use presently is being made of Y but Z is in agricultural use which is producing a net income of $20 per acre. The cost of bringing utilities to Z and developing streets would be $150,000 greater than to supply these to Y because of soils and terrain, but exclusive of site location. With protection but without development, the raw value on account of location of Y for homesites is $1,000 per acre compared to $500 for Z. Development of either area would occur over a 20-year period. The evaluation might take this form using 3 percent interest, an evaluation period of 100 years and a uniform rate of development over the first 20 years.

Amortized advantage of Y over Z for homesites ($100,000 x 0.03165)	$ 3,165
Amortized advantage of Y over Z in utility development ($150,000 x 0.03165)	4,748
Loss of farm income not incurred in area Z (200 acres x $20)	4,000
Total annual advantage of Y over Z	$11,913

The $3,165 added value for homesites will accrue immediately after protection and will not need to be discounted. The remaining $8,748 will accrue over the development period and will be discounted to $6,587 at 3 percent interest (factor .753). Thus the total benefit will be $9,752.

In this instance it was assumed that there would be no difference in the value of the housing in Y and Z that would not be reflected in land values.

In case there had been no alternative area for development, and protection by the project had permitted the city to grow only by expanding into Evaluation Reach Y, the evaluation would have been concerned only with the area being developed.

The preferred method would have been to have appraised the increase in the capital value of the land after development in comparison with its value in its original state. Next all associated costs of development would have been deducted. The net increase then would be converted to its annual equivalent value.

A less direct method would have been to determine rental values after development. When using net rental values it is realistic to assume something less than 100 percent occupancy. Full allowance should be made for such items as interest on the investment, depreciation, repairs, taxes and the like. The general principles involved are similar to those illustrated under Changed Use of Agricultural land.

VIII. ADJUSTMENTS IN BENEFITS

In nearly all cases of enhancement-type benefits, the final benefit creditable to the project will need to be determined after consideration of such factors as the rate of benefit accrual and the effect of the remaining flooding or other incomplete removal of risks that the project is designed to remove.

A. Adjustments for Lag in Accrual

Enhancement-type benefits seldom can be expected to reach their full value immediately after project installation. Time will be needed to clear land or otherwise get it in physical shape for production after flood protection is provided. Time may be required for recovery from disturbance occasioned by land leveling, and installation of on-farm drainage or irrigation systems.

In addition to the delays caused by these physical factors, there are delays stemming from management and financial limitations. Farmers may not have the capital to take immediate advantage of project facilities. They may need time to discover the best production patterns and the inputs needed for most profitable production. This may be especially true in the case of new irrigation developments where time is needed to learn when to irrigate, how much water to apply, and the response to fertilizer. It often may happen that a farmer is semi-retired and will not expand production during his tenure.

If the time lag between installation and full production is but a year or two, it does not need to be considered. But if it approaches five years or is longer, appropriate discounting is necessary. Several illustrations are shown in this chapter. A more complete discussion together with certain short-cut discount factors appears in Section IV of Appendix A.

B. Adjustments for Remaining Flood Damage to Higher Value Use

When a project permits a shift to higher value use, susceptibility to damage if a flood should occur is increased. Complete flood

protection to agricultural areas seldom is provided. As a result, the remaining floods cause higher damage than if the land were in its original use.

The damage can be calculated by evaluating the effect of the flooding on the new damageable value with project installed. The excess of this damage over that found when the original damageable values were used should be deducted from the gross benefit from enhancement.

This correction is most important when agricultural values are involved. Non-agricultural enhancement ordinarily will not be undertaken unless a high level of protection is provided.

C. Other Adjustments to be Considered

Adjustments of benefits may be needed when projects are developed for irrigation or drainage. In either case, through capital or other limitations, some of the potential beneficiaries may fail to take full advantage of the project facilities. A common failure may be that on-farm installations are not maintained at full efficiency.

A common method of handling this problem is to examine the operation of similar nearby areas where these improvements are in operation. Based on such analyses, the potential benefits from the project are adjusted downward for the expected percentage of participation or the degree of effective maintenance.

A somewhat different adjustment is needed when it is not practicable to provide sufficient water to meet full irrigation needs 100 percent of the time. In this situation it is recommended that the adjustment be made in the crop enterprise budgets by reducing the projected yield below that which could be obtained with a full water supply. In most cases the water supply will be adequate for some of the crops. Farmers can be expected to use available water for those crops where the response is greatest. Therefore, adjustments probably will be needed in the yields of crops which are least responsive to additional water.

CHAPTER 5

SEDIMENT AND EROSION

This chapter deals with the economic evaluation of land damage by erosion and sedimentation. It describes methods that are suitable for use in evaluating damage to improvements on the land that is caused by erosion and sediment. Included also are methods for evaluating sediment damage to irrigation and drainage facilities and reservoir sedimentation.

I. EROSION AND SEDIMENT DAMAGE TO AGRICULTURAL LAND

The method to be used in the economic evaluation of land damage should be based on whether the damage is permanent, or only temporary with some degree of recovery of productivity possible. Where permanent damage to land is occurring or imminent the method selected for estimating this damage should reflect the significance of this permanent loss to all interests. Where damage to land is not permanent, which assumes that at least partial recovery of productivity is possible either through natural processes or other physically or economically feasible means, the public interest, although present, is not as significant.

It should be kept in mind that evaluation of land damage is the joint responsibility of the economist, and such physical scientists as geologists, agronomists and soil scientists. The economist needs the data provided by the physical scientists to make an economic evaluation. A close working relationship between these technicians is essential to efficient and adequate land damage evaluation.

A. Types of Land Damage

1. Erosion Damage

For the purposes of this chapter erosion damages are classified and evaluated under the headings of gully, streambank and flood plain scour. Land may or may not recover from erosion damages. However, in most instances gully and streambank erosion is a permanent or non-recoverable damage. Flood plain scour is usually temporary in that recovery of productivity is usually physically and economically feasible.

2. Sediment Damage

Sediment damages to land may be classified as deposition damage or swamping damage. Sediment damages also occur to improvements and facilities. Some of the more common damages of this nature occur to reservoirs, residences, factories, etc.

Deposition damages are those occurring when damaging sediment is deposited on the land. Productivity of the damaged land is usually considered to be recoverable. However, if the deposited materials is in the nature of large boulders or great depths of infertile material the damage may be non-recoverable.

Swamping damage occurs when stream channels become clogged with sediment and/or natural levees are formed by sediment deposition. In most instances swamping damage can be corrected by works of improvement.

Sediment damage to items other than land can be considered recoverable where it is feasible to correct the damage.

II. METHODS OF EVALUATING LAND DAMAGE

The following methods are acceptable in the evaluation of land damage. As in all economic evaluation, one of the reasons for determining damages is to calculate the benefits that will accrue by a reduction of these damages by project measures. As pointed out in Chapter 1 of this Guide the "with project" and "without project" approach should be used in estimating benefits from preventing land damage.

A. Evaluation of Permanent Land Damage

A common type of permanent land damage is gully erosion. It occurs as land voiding and associated depreciation of productive capacity of other acres on a farm unit, especially those acres adjacent to the voided gully area. Illustrated below is an evaluation procedure, along with basic assumptions and definitions of terms, specifically applicable to gully erosion.

The damage evaluation takes account of: (1) loss of income to farm operators during a 10-year adjustment period, (2) market value of the loss to landowners of a land resource, (3) value of the loss of real estate tax base source of income, and (4) value of the loss to public interests not reflected in the market value of a land resource.

1. Basic Determinations and Definition of Terms

The following factors will be taken into account in making estimates of damages involved from land voiding and associated land depreciation:

a. Level of Production and Pattern of Land Use

The land use and cropping pattern (crop rotation) considered for this evaluation will be that which is within the criteria and standards of the use capabilities of the land, ordinarily determined

through soil surveys and land use capability classifications. The level of yields used will be those obtained by farmers following a moderately high level fertility and management program and an intensity of farming operations consistent with the most intensive practical cropping pattern applicable within the area. Where associated soil and water conservation measures are necessary to make possible the above level of intensity of farming the average annual value of the costs of these required associated measures must be deducted from the total average annual damage. All of these considerations for evaluation purposes are made upon the basis of what could be expected with the proposed erosion control measures installed.

b. Gross Income

The gross income from the lands projected to be damaged will be determined on a per acre basis as the monetary values of all the products grown on the area, e. g., field crops, pasture, and woodland times their respective projected price per unit. These values, when weighted, will give the composite per acre gross income figure for the land that would be voided and depreciated without the proposed project.

c. Adjusted Gross Income

This will be determined as the remainder after all cash operating costs1/ have been deducted from the gross income (item "b" above). These cash operating costs are those out-of-pocket costs such as fertilizer, gasoline, oil, hired labor, processing and marketing expenses, etc.

d. Real Estate Tax Charges.

e. Returns to Land

This is considered as the net return to land or rental value from the acre of land after real estate taxes are deducted. As used here the term "net return to land or rental value" is generally comparable to the "long-run" net return that would accrue to a landlord were the land rented to a tenant. The prevailing rental rate (share or cash) should be weighted into the composite rental value.

1/ One way to determine these costs would be to total up all of the annual cash out-of-pocket operating costs the farmer would not have to pay if any individual acre subject to damage were to be 100 percent destroyed by gullying. By not being able to farm the destroyed land the farmer would not incur the normal cash operating costs required to produce a crop on the land. Thus, these costs saved are deducted from the gross income in order to arrive at a net loss figure for use in the evaluation.

f. Returns to labor, capital and management of the farm operator.

This will be determined as the difference between adjusted gross income (item "c" above), and the returns to land (items d and e above).

2. Procedure for Erosion Damage Evaluation

The evaluation of damage will be based upon the annual physical land losses, as determined by the geologist, and upon the depreciation on lands adjacent to and associated with voided gully areas, as determined jointly by the geologist and the economist. The geologist will supply the annual rate in acres that will be subject to actual physical damage from gullying.

Various degrees of depreciation take place on lands immediately associated with the fully voided gully areas. The "fingerlings" or lateral gullies formed from the main gully establish a pattern which makes it necessary to abandon field cropping on most of the acres in between but permits use of the land as pasture or woodland. These acres are a part of the depreciated (but not fully depreciated) erosion area. It will be the joint responsibility of the geologist and the economist to determine the additional area or areas of land that will be subject to some form of depreciation in productive capacity as a result of the gullying process. If desired and before making the monetary evaluation these depreciated acres may be added to the voided gully acres supplied by the geologist as referred to above. Otherwise, the two types of damage, "voided" and "depreciated" will need to be evaluated separately. In the illustration to follow the two have been added and a composite acre developed. Care should be taken to assure that losses are not claimed for more acres than can be physically damaged within the 100-year period.

It is appropriate, therefore, to measure damages and to base benefits on the net reduction in expected production, that is, the difference in net income between undamaged or "with" project, and the damaged or "without" project conditions.

a. Illustration of Procedure

The evaluation of land damage from gully erosion, a permanent type of damage, is illustrated in Table 5.1.

Table 5.1

Annual Returns and Costs per Composite Acre of Gully Erosion Area

	Income Values per Acre		
	With Project	Without Project	Damage
(1) Gross income	$60.00	$4.00	$56.00
(2) Cash operating costs	15.00	1.00	14.00
(3) Adjusted gross income	45.00	3.00	42.00
(4) Returns to land after deducting real estate taxes	13.50	1.80	11.70
(5) Real estate taxes	1.50	.20	1.30
(6) Remaining returns to farm operation	30.00	1.00	29.00

(1) Present worth of annual damages per composite acre:

(a) Loss of income during a 10-year adjustment period ($29.00 declining at the rate of $2.90 per year @ 6%) $127.60

(b) Market value of loss to landowner(s) (capitalized value of $11.70 @ 6%) 195.00

(c) Value of loss to local interests of real estate tax base source of income ($1.30 capitalized @ 3%) 43.33

(d) Value of the loss to social interests not reflected in reduced market value of a land resource ($11.70 capitalized @ 3% less market value of $195.00) 195.00

(e) Total gully erosion damage to one acre $560.93

b. Explanations pertinent to use of the procedure:

(1) Loss of income to farm operators during a 10-year adjustment period.

This period of years is considered as reasonable for the average situation wherein farm operators have become aware of the importance of making and have made alternate uses of that part of their labor, capital and management made idle because some land on their operating units is voided or severely depreciated by gully erosion. For each composite acre voided and depreciated this will be the value of the returns to remaining labor, capital and management of the farm operator which would be foregone at a decreasing rate for a 10-year adjustment period.

In the tabular illustration above ((1) (a)) the \$127.60 annual loss per acre is determined by use of the P.V. Factor of a decreasing annuity for 10 years, at 6%, 43.99853 x \$2.90. The reduced returns to farm operators (item (6) page 5) is \$29 initially, but spread over the 10-year adjustment period returns would be foregone "without project" at an average decreasing rate of \$2.90 per year.

(2) The value of the loss to public interests not reflected in the market value of a land resource is exemplified by comparison of the rates of interest reflected over time for social productivity of capital with that for discount rates on private investments. In the first instance it is 3 percent and in the other it is 6 percent. (This interest rate of 3% reflects the social productivity of capital and is not to be confused with the Federal interest rate currently used in connection with computing costs under P.L. 566).

The value of the loss to public interests is a primary damage, and its reduction is a primary benefit, because it represents a net loss to the public of a part of the net farm returns that cannot be recovered by other alternatives in the economy. This loss results because individual and social net returns are usually not identical. Thus, private and public interests in preventing the loss of land are not identical because of differences in time preferences. Society is expected to have an interest in land to perpetuity, while an individual may only have a short span interest which is usually limited to his expected life plus that of a few descendents.

In the tabular illustration above, (item (d) page 5) the \$195 annual damage per acre is determined, (1) by capitalizing at 3% the \$11.70 annual returns to land after deducting real estate taxes (\$11.70 ÷ 3%), giving \$390, (2) by subtracting from it the capitalized value at 6%, which is the private entrepreneur rate of interest, or the \$195 determined for market value of the loss to landowners (see item (d), page 5, in the tabular illustration).

(3) The summation of the four types of damage reductions evaluated, totaling \$560.93 in the tabular illustration above (item (e), page 5) is also the annual benefit per acre "with" project and needs no further evaluation where an annual loss of one acre extends over the entire evaluation period. This is based on the assumption that gully erosion stabilization measures installed will, for this purpose, have annual operation and maintenance sufficient to assure (1) their usefulness beyond the project evaluation period, and (2) the permanent and complete stabilization of the gully. This assumption is pertinent because determination of these benefits (\$560.93) is based upon returns into perpetuity with project. Therefore, in determining the benefits, all annual O&M cost required to assure the full level of benefits into perpetuity should be deducted from the benefits (\$560.93) as determined above.

c. Application of the Procedure

(1) The physical losses for purposes of this economic procedure must be expressed as average annual acres damaged during the period of project evaluation. The total annual damage determined per composite acre can then be multiplied by the acreage of land annually damaged. Example: If the average rate of land damage is 1.2 acres per year for the project evaluation period, then the annual damage would be $560.93 times 1.2 acres or $673.12 1/.

(2) Adjustment in the damage per acre where the area subject to damage will be exhausted within a period of less than 100 years is necessary.

In those cases where the total area subject to damage is small and the rate of damage is such that the remaining area subject to damage will not permit the rate to continue for a full 100-year period, it will be necessary to modify the damage figures used in (2) (a) through (2) (d), page 5, to bring them into line with the actual number of years over which the rate of damage will occur. For example, suppose that the rate of damage is 1 acre per year, and 30 acres is the remaining area subject to damage. Then the maximum period over which damage can occur would be 30 years. By using the total damage to one acre ($560.93) shown on page 5, the adjusted per acre damage rate can be determined. The value of $560.93 can be treated as an annuity for the given period, discounted to present worth for the period of accrual, and amortized over the project life. Thus, where one acre is lost per year for 30 years, the answer would be:

$560.93 x 19.60044 (present value of an annuity of 1 at 3% for 30 years) = $10,994.47.

$10,994.47 x 0.03165 (100 yr. amortization factor at 3% = $347.97 2/.

(3) Modification of Procedure where Partial Protection is Provided with Project

The procedure illustrated under a., page 5, assumes essentially full protection from gully damage with project. On lands in an evaluation reach or area where less than full or only "partial" protection is to be provided by the project a modified procedure must be used to arrive at the benefits. For example, a single gully may eventually damage 100 acres of land without protection. With project

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1/ See item II. A. 1. a, page 2.
2/ See page 3 concerning any required associated costs.

it is possible to give essentially full protection to 40 of the 100 acres. On the 40 acres the procedure illustrated under a., page 5 should be used. On the balance, or 60 acres, only "Partial" protection can be provided. On both the 40 and 60 acres, "without project," the per acre annual damage will be the same, or $560.93 as shown under a. Since only partial protection is possible on a part of the area (60 acres) the benefits will necessarily be less than for the fully protected area. The modified procedure outlined below is, therefore, designed to arrive at these benefits. In the example, a somewhat less intensive cropping pattern is shown in table 5.2 as compared with table 5.1, because of the remaining gully erosion hazard. This also accounts for a lower level of returns with only partial protection.

In connection with item (a) in the following example the "loss of income prevented during a 10-year adjustment period" has been limited to a 100-year evaluation period rather than extended into perpetuity as was the case under the preceeding example. (See (1) (a), page 5).

It should be noted also that a higher interest rate, 4 rather than 3 percent has been used to determine the value of loss prevented to local interests, item (c) and the value of loss prevented to social interests, item (d), than was the case under full protection. The reasoning here is that partial protection will only slow down the rate of loss rather than prevent it entirely, consequently, a higher discount rate is applied to reflect a lesser social interest in merely slowing down versus preventing any future losses.

Table 5.2

Annual Returns and Costs per Composite Acre of Gully Erosion Area

	Income Values per Acre		
	With Partial Project Protection	Without Project	Difference With Partial Protection
(1) Gross income	$50.00	$4.00	$46.00
(2) Cash variable costs	14.00	1.00	13.00
(3) Adjusted gross income	36.00	3.00	33.00
(4) Returns to land after deducting real estate taxes	10.50	1.80	8.70
(5) Real estate taxes	1.50	.20	1.30
(6) Remaining returns to farm operation	24.00	1.00	23.00

The present worth of annual benefits per composite acre with partial protection will be:

(a) Loss of income prevented during a 10-year adjustment period ($23.00 declining at the rate of $2.30 per year at 6%) = $101.20

(b) Market value of loss prevented to landowner(s) $8.70 x present value of an annuity of 1 per year for 100 years at 6% ($8.70 x 16.61755) = 144.57

(c) Value of loss prevented to local interests of real estate tax base source of income. $1.30 x PV of an annuity of 1 per year for 100 years at 4% ($1.30 x 24.50500) = 31.86

(d) Value of the loss prevented to social interests not reflected in reduced market value of a land resource - $8.70 x PV of an annuity of 1 per year for 100 years at 4% ($8.70 x 24.50500) = $213.19 - (market value, item 2 above) $144.57 = 68.62

(e) Total benefit from preventing gully erosion damage to one acre with partial protection - $346.25

For one acre damaged annually the following figures would result:

Damage without project $560.93.

Damage with partial protection $214.68 ($560.93 - $346.25).

Benefits with partial protection $346.25.

The per acre annual benefit, $346.25, multiplied by the rate of loss per year as determined by the geologist will give the total annual benefits expected to accrue on the 60 acres provided with partial protection.

(4) Application of Method to Other Types of Permanent Land Damage Evaluation.

The economic evaluation methods as described above for gully erosion may also be used for the purpose of determining other types of permanent damage to land, such as streambank erosion. It is not acceptable, however, for use in the calculation of overbank deposition, swamping or flood plain scour, where recovery of productivity is possible, since the element of recovery prevents this type of damage from being one to an irreplaceable resource.

B. Evaluation of Land Damage Subject to Equilibrium or Recovery

A number of suitable methods have been developed and used in the past to evaluate land damages subject to equilibrium or recovery of productivity, and one of these is included here for illustrative purposes. Other methods may be used provided they follow the basic economic principles set forth elsewhere in this Guide.

The selection of the method to use will depend at least partially upon the physical and economic data available for use in the evaluation. Another guiding criterion in the selection of an appropriate method is the expected rate, severity and location of future damages. Generally the evaluation consists of determining the difference in income from the flood plain land under consideration "with" and "without" the project measures. Usually land treatment measures play an important role in the reduction of these kinds of land damages. This is particularly true where the main source of damage is from sheet erosion.

Two basic situations are frequently encountered when appraising such land damage. First, areas will be found where new damage is approximately in equilibrium with recovery of productivity on old damage areas. In this case the benefits to be derived with a program will consist of reducing the rate of damage so that the equilibrium point will be shifted in the direction of less loss in income. Second, another situation encountered will be where an increase in the area damaged is taking place and recovery, due either to natural processes or normal farm operations, is also present.

1. <u>Suggested Evaluation Method Where Damage and Recovery are in Equilibrium</u>

Data will be obtained from the geologist and other physical scientists on the total area damaged and the loss in productivity. The economist will then evaluate the annual net loss in income from this damaged area as the present damage. The geologist will supply an estimate as to the portion of the damage that could be expected to recover were it no longer subjected to flooding or deposition. The economist will consider that the <u>non-recoverable</u> portion of the sediment damage (the loss in value of production from this portion) will continue after the installation of a program. He will then apply the reductions in flooding and deposition of less fertile overwash to the <u>recoverable</u> portion in order to determine the benefits from the reduction of damage accruing from the project.

To illustrate, let us assume that a flood plain under undamaged conditions had 4,000 acres. Assume also that on this undamaged land the annual gross value of production would be $80.00 per acre, with production costs of $45.00 and a net return of $35.00 per acre. An analysis of costs and returns on the area, by percent damage classes, shows the following:

Table 5.3 - Per Acre Cost, Returns and Loss on Damaged Land

Yield Reduction (Percent)	Gross Production (Dollars)	Cost of Production (Dollars)	Net Return (Dollars)	Loss (Dollars)
Undamaged	80.00	45.00	35.00	0
10	65.00	35.00	30.00	5.00
30	50.00	32.00	18.00	17.00
50	37.00	28.00	9.00	26.00
70 1/	22.00	18.00	4.00	31.00
90 2/	7.00	5.50	1.50	33.50

1/ Shifted to lower value crops
2/ Low grade pasture

Next, let us assume that the physical scientist has appraised the physical damage and provided the economist the data shown in the first two columns in Table 5.4:

Table 5.4 - Summary of Total Average Annual Damage

Percent Damage	Acres Damaged	Damage Per Acre (Dollars)	Total Damage (Dollars)
10	1200	5.00	6,000
30	600	17.00	10,200
50	300	26.00	7,800
70	60	31.00	1,860
90	10	33.50	335
TOTAL	2170	xx	26,195

The figure $26,195 is the total annual loss in net crop and pasture income from the 4,000 acre flood plain because of land damage.

2. <u>Suggested Evaluation Method Where the Rate of Damage is Increasing and Recovery is Taking Place</u>

This method takes into account the fact that, in most instances, the period over which a given rate of damage can occur is limited by either the area subject to damage, characteristics of the land, or the maximum decline in productivity and income expected.

The geologist will provide an estimate of the rate at which the damage is progressing, plus an estimate of the eventual limits to the damage in terms of the total area that may be affected.

Assume, for example, that in the flood plain shown in Table 5.3, the area being damaged is increasing 20 acres per year and will continue until 200 additional acres have been subjected to damage. By damage classes the annual increase in damage is as follows:

Percent Damage	New Damage Per Year (Acres)	Damage Per Acre (Dollars)	Annual Rate of Increase (Dollars)
10	10	5.00	50.00
30	5	17.00	85.00
50	5	26.00	130.00
TOTAL	20	xxx	$265.00

For the 10 percent damage category, 10 additional acres are being damaged annually at the rate of $5 per acre, or a total increase of $50 per year. It can be seen that this damage is similar to an increasing annuity. The present value of an annuity increasing by one per year for 10 years is 41.99225 at 4 percent interest. After 10 years 1/ the damage will stop increasing and will remain constant for the balance of the 100-year evaluation period, or for 90 years. Thus, we have the following:

$50 x 41.99225 = $2,100 (Incremental damage during first 10 years.)

$500 x 24.26728 2/ = $12,134 (Value of damage last 90 years of evaluation period.)

$12,134 x 0.67556 3/ = $8,197 (Present worth of damage for last 90 years.)

1/ 200 acres ÷ 20 acres = 10 years or the number of years required for 200 acres to be damaged at the assumed rate of 20 acres per year.
2/ Present value of an annuity of 1 per year for 90 years.
3/ Present worth of 1 ten years hence.

The total loss on the area subject to increased damage is \$8,197 + \$2,100 = \$10,297. The average annual equivalent value thus becomes \$10,297 x 0.04081 = \$420.

Calculations using the same years and interest and discount factors for the 30 and 50 percent damage categories give annual damages of \$714 and \$1,093 respectively.

Thus, the loss due to increasing damage becomes \$420 + \$714 + \$1,093, or \$2,227. A short-cut method of arriving at the total would be to use the total annual rate of increase of \$265 and follow through the steps shown for the 10 percent category. The actual calculation would be:

\$265 x 41.99225	= \$11,128
\$2,650 x 24.26728	= \$64,308
\$64,308 x 0.67556	= \$43,444
\$43,444 + \$11,128	= \$54,572
\$54,572 x 0.04081	= \$ 2,227

The above total of \$2,227 is the annual increment of loss on new acres being damaged and does not account for future production loss on areas already damaged. The next step then would be to combine the production lost in Table 5.4 with the \$2,227. This is illustrated in Table 5.5.

Table 5.5 - Annual Value of Damage

Percent Damage	Damage on		Total
	Area Already Damaged	Area subject to Increasing Damage	
	(dollars)	(dollars)	(dollars)
10	6,000	420	6,420
30	10,200	714	10,914
50	7,800	1,093	8,893
70	1,860	-	1,860
90	335	-	335
TOTAL	26,195	2,227	28,422

In those cases where the rate of land damage is increasing, appropriate adjustments will need to be made in the damageable values and in the estimates of crop and pasture damage from floodwater in order to prevent double counting of damage on the same area. This adjustment can be made in several ways. One approach is to first convert all damage sustained to date (Table 5.4) to equivalent acres of total or 100 percent damage. This can be easily found by multiplying the "acres damaged" column by the "percent damage" column in Table 5.4. The result is 501 acres.

In terms of productive capacity the 4,000-acre flood plain, because of flooding, has been reduced to 3,499 acres (4,000 - 501). The estimated annual equivalent damage will increase by $2,227 or ($2,227 ÷ $26,195) 8.5 percent of the value of productivity lost on the "area already damaged," Table 5.5. Then 501 x 0.085 = 43 additional acres totally damaged that will be lost during the 100 year evaluation period. Then 3,499 - 43 = 3,456 acres. By taking the ratio of acre equivalents of undamaged land for "future without a program" (3,456) and "present without a program" (3,499) we get a factor of 0.99. The estimated annual floodwater damage to crops and pasture on the area subject to increasing land damage can be adjusted by applying the above factor (0.99).

Since recovery is also involved in this method it will be necessary to make appropriate corrections in the figures in order to take account of this item. For illustration, assume that in the 4,000-acre flood plain used in this example the geologist furnishes the following estimates:

Percent Damage	Years to Recover	Percent Damage After Recovery
10	5	0
30	10	10
50	15	30
70	20	50
90	50	70

With the above data given, it is now possible to adjust for the recovery factor in the damage calculation. Using the 50 percent damage class for illustration and going back to Table 5.1 we find that a net loss of $26.00 per acre is shown for the 50% damage rate. From the information supplied by the geologist, this area can recover in 15 years to the point where a 30% damage will remain. Table 5.1 also shows the net loss for the 30% damage to be $17.00 per acre. Then $26.00 - $17.00 or $9.00 per acre is the eventual value of recovery for the 50% damage.

Assuming a uniform recovery, the straight line discount factor for a 100-year evaluation period for a 15-year lag is 0.767 at 4%. Then $9.00 x 0.767 = $6.90. The other values in the tabulation may be derived in a similar manner. In summary we then have the following:

Percent Damage	Acres to Recover	Per Acre Value Undiscounted (dollars)	Per Acre Value Discounted (dollars)	Total Recovery (dollars)
10	1,200	5.00	4.62	5,544
30	600	12.00	10.08	6,048
50	300	9.00	6.90	2,070
70	60	5.00	3.50	210
90	10	2.50	1.09	11
TOTAL	2,170	xxx	xxx	13,883

The difference between the $26,195 annual loss on the area already damaged (Table 5.5) and the $13,883 is $12,312 or the non-recoverable portion of the damage. This $12,312 of non-recoverable damage need not be considered further in the analysis. The $13,883 of annual recoverable damage plus $2,227 of increasing damage equals $16,110 of preventable damage with a 100 percent effective program.

III. EVALUATION OF DAMAGE TO IMPROVEMENTS FROM GULLY AND STREAMBANK EROSION

Gully and streambank erosion often damage nonagricultural property, including highways, bridges, culverts, streets, business, residential and other structures, as well as farm improvements and structures such as buildings, fences, roads, etc. Expenditures made for temporary or emergency measures for protection of improvements and structures from gully and streambank erosion should be included in the average annual damage figure. Where it is feasible to relocate buildings and structures, the damage without the project can be estimated by determining the cost of relocation, including any loss in income or services because of relocation. In the case of expected damage to the highways, the cost involved in repairing the initial damage to the highway, plus the initial bridging and future bridging costs during the time the gully enlarges to its maximum width and extent, can be used as the basis for evaluating expected damage without a project. Where a significant period is expected to elapse before relocation, repair, or other expenditures brought about by gullying, appropriate discounting procedures should be employed.

The evaluation should be based on conditions expected to prevail with and without project. In certain instances gully or streambank erosion can be expected to progress to the point that specific structures,

businesses or properties, will be damaged or destroyed. Where it is not feasible to relocate a structure, or where property is irreplaceable, the damage can be considered as equal to the present value of the structure less salvage value. Where relocation of the structure is feasible, the damage can be estimated by determining the cost of relocation, including any loss of income or business because of location.

Typical calculations of average annual damage expected without the program are shown below. (The damage figures represent the average annual equivalent values of expenditures that will not have to be made if stabilization measures are installad.)

A. Where Relocation of Property is Feasible.

Cost of relocation	$6,000
Years to point where gullying causes relocation	5
Average annual damage $6,000 x 0.86261 x 0.03165	$ 164

Discount factor: 0.86261 P.V. of 1, 5 years at 3% interest.

B. Where Gullying is Expected to Damage a Highway.

Cost to repair or replace the highway and bridging costs	$20,000
Years to point where gullying causes expenditures	5
Average annual damage $20,000 x 0.86261 x 0.03165	546

Discount factor: 0.86261 P.V. of 1, 5 years at 3% interest.

C. Where it is Not Feasible to Relocate a Structure or Business.

Value of Structure, business and business property, less salvage value	$100,000
Years to point where erosion destroys structures, business or property	5
Average annual damage $100,000 x 0.86261 x 0.03165	$ 2,730

Discount factor: 0.86261 P.V. of 1, 5 years at 3% interest.

D. Where Relocation of Business or Property is Feasible.

Cost of relocating structure, residence, etc.	$5,000
Years to point where erosion causes relocation	7
Average annual damage $5,000 x 0.81309 x 0.03165	$ 129

Discount factor: 0.81309 P.V. of 1, 7 years at 3% interest.

IV. EVALUATION OF SEDIMENT DAMAGE TO RAILROADS AND HIGHWAYS

In many instances local governments and railroad companies spend considerable sums for the removal of sediment to maintain transportation services and to protect investments in roads and structures. Most frequently the expenditures are made to remove sediment from road surfaces, road ditches, culvert and bridge openings, and from those drainageways served by bridges and culverts. The removal of sediment from bridges and culverts and adjacent drainageways is usually done to protect structures, including road surfaces and roadbeds, from overflow or other types of floodwater damage. The extent of such expenditures may be treated as representing sediment damage to highways and railroads. Occasionally sediment is not removed in sufficient quantities to maintain services or prevent damage. In these cases, the cost of removing sediment necessary to maintain services may be estimated and used in evaluating the average annual damage expected without a project.

In most instances the average annual damage can be calculated by obtaining the sum of expenditures for sediment removal over a representative period of years and dividing by the number of years of record. The expenditures for removing sediment from culverts and bridges and drainageways adjacent thereto should be separated from the cost of removing sediment from road ditches or for removing sediment from road surfaces. As to road ditches, often a major source of the material removed is from the road surface and its replacement is a part of normal road maintenance and should not be evaluated as a sediment damage. In such cases the additional expense occasioned for the removal of sediment, originating from erosion at sources other than road surfaces, should be estimated and used in the damage evaluation. It is important to obtain from the informant an estimate as to what, in his opinion and experience, is the source of sediment being removed. With this information, along with that obtained from investigation by physical scientists with respect to the source of sediment, it will be possible to estimate the benefits of the project in reducing sediment damage either through erosion control measures, waterflow control measures, or measures for sediment entrapment.

V. EVALUATION OF SEDIMENT DAMAGE TO MUNICIPAL AND INDUSTRIAL WATER SUPPLIES

The sediment content of water used for municipal and industrial purposes may result either in expenditures for treating water so that it is suitable for these purposes, damage to machinery or other water facilities, or impairment of the quality of the manufactured product. (Sediment damage evaluation considered here is not concerned with loss of reservoir storage capacity.) In some instances, these adverse effects may be factors influencing the location of water storage facilities or the location of industrial plants resulting in a more costly supply of water or less efficient production than would otherwise be the case. These costs involve conditions that are difficult to establish with a reasonable degree of acceptance.

Usually the monetary evaluation of sediment damage can be made by obtaining the expenditures made by municipalities or industrial concerns for treatment of water to correct the damaging effects of sediment, or by obtaining estimates of damage to machinery and the reduction in quality of product. In some instances water is treated to correct the sediment content as well as other conditions affecting the use of water. In such instances only the additional treatment costs made necessary because of sediment should be used in evaluating sediment damage. In appraising the damage to machinery, expenditures for repairs and the reduced life of machinery can be used as the basis for estimating the average annual damage. Where the useful life of machinery or other water supply facilities is impaired, estimates of the value of machinery affected and the expected life of the property with and without sediment damage should be obtained from the owners. This will provide the information necessary to express the damage as the difference in the amounts of sinking fund with and without damage. Interest rates used in calculating sinking funds should reflect the interest paid by the property holders affected. Losses due to reduction in quality of product can be estimated by obtaining from the manufacturer the increase in market price that could be realized for the product without the adverse effects of the sediment content of water. Any additional costs of processing, distributing, and marketing the higher quality product should be deducted from the increase in value of the product. Sample calculations of average annual damage are presented below.

Improved quality of product:

Gross value of product without sediment damage	$500,000
Gross value of product with sediment damage	450,000
Difference	$ 50,000
Additional cost of processing, distributing, and marketing the higher quality product	$ 15,000
Average annual damage (50,000 - 15,000)	35,000

Water Treatment Costs:

Total average annual expenditures	$ 3,000
Expenditures because of other than sediment content of water	2,500
Annual treatment costs attributable to sediment	$ 500

Machinery repair costs:

Expenditures for repairs due to sediment (average annual)	$ 4,000

Reduction in useful life of machinery because of sediment:

Useful life without damage	15 years
Useful life with damage	12 years
Cost of replacing machinery	$100,000.00
Salvage value of machinery	$ 10,000.00
Difference	$ 90,000.00

Calculation of average annual damage:

With damage $90,000 x (0.10046) 1/	=	$ 9,041.40
Without damage $90,000 x (0.08377) 1/	=	$ 7,539.30
Difference		$ 1,502.10

0.10046 Amortization factor, 12 years at 3% interest 1/
0.08377 Amortization factor, 15 years at 3% interest 1/

VI. EVALUATION OF SEDIMENT DAMAGE TO EXISTING OR NON-PROJECT DRAINAGE AND IRRIGATION FACILITIES

Unless removed, sediment deposited in open drainage ditches impairs drainage and causes a gradual reduction in crop yields and income. Usually ditches are cleaned out periodically. Remedial measures for sediment control will lengthen the period between cleanouts. For practical purposes, damage with and without the project can be calculated by using the method described under IV for railroads and highway.

Ditch cleanout costs often include expenditures other than for sediment removal. In such cases appropriate adjustments should be made to eliminate costs other than those related to sediment removal.

1/ Sinking fund factors at 3% for 15 and 12 years respectively could be used instead of amortization factors.

VII. EVALUATION OF RESERVOIR SEDIMENTATION

A. Evaluation Methods

Damages to reservoirs (and benefits) may be estimated by different methods, depending upon (1) the amount of information that is available or that can be obtained within the limitations of budget and other resources, (2) the number of reservoirs to be evaluated, and (3) the importance of the monetary benefits accruing from reduced rates of reservoirs sedimentation in relation to the overall economic justification of a water resource project. The four most common methods used are referred to as (1) straight-line, (2) sinking fund, (3) sinking fund plus service loss, and (4) cost of sediment removal.

1. Straight-line

This method is simple to use and in P.L. 566 damage evaluations it is the preferred method, hence it is described in detail below.

The average annual damage is estimated as the product of the average annual rate of sedimentation in acre-feet and the original cost of storage per acre-foot adjusted to projected prices. The average annual benefit is the difference between the average annual damage with and without the project.

a.	Adjusted cost per acre-foot of total storage	\$60.00
b.	Volume of sediment deposited annually without the recommended project	335 ac. ft.
c.	Volume of sediment deposited annually with the recommended project	168 ac. ft.
d.	Average annual damage without project (335 x \$60)	\$20,100
e.	Average annual damage with project (168 x \$60)	\$10,080
f.	Average annual benefit (d - e)	\$10,020

CHAPTER 6

DRAINAGE MEASURES

Drainage measures produce benefits that consists primarily of increases in annual agricultural income resulting from the increased production of agricultural commodities or reduced cost of production. Drainage benefits are largely on-site and may include the following: (1) Increases in agricultural income with the project less any costs associated with the increase, and (2) other benefits, not evaluated in monetary terms, such as, improvements in wildlife habitat and production and (3) reduction in health hazards.

I. BASIC DATA

The following data is necessary to measure the physical and monetary benefits of drainage measures.

A. Soils

Soil information should be collected and summarized for the area requiring drainage. Soils should be grouped by capability classes, subclasses, or by soil mapping units, whichever is most applicable.

B. Land Use and Crop Yields

Determine by interviews and/or field inspections present land use and crop yields and anticipated land use and crop yields (both with and without drainage). At the same time, information needed for the development of budget analyses for the "with" and "without" drainage conditions should be obtained from farm owners and operators. Such field information should be supplemented by and checked against reports from like areas where drainage improvements have been installed and from other secondary sources.

Information on present and anticipated land use and crop yields for each major soil grouping will provide basic data needed to determine the relative economic advantage of various alternative drainage plans and/or incremental degrees of drainage. Aerial photographs of size and detail adequate to record soil groupings, land use, crops and yield data are useful in delineating sub-areas and establishing evaluation procedures. Where a sampling process has been followed, aerial photographs are excellent to establish validity of the sample and degree of expansion to cover the problem area.

Land use and yields may be restricted by the relative elevation of the water table. Therefore, in estimating future use and yields with the project, consideration should be given to level of control provided by the drainage measures. This may necessitate separate evaluation subareas.

In estimating future yields under non-project conditions, assume the application of on-farm drainage measures and adoption of technological improvements that can reasonably be expected in the absence of the project.

Estimates of future yields with the project should consider the application of land treatment measures necessary to meet the need for drainage. The estimate also should include the effects of technological improvements that can reasonably be expected with the project.

The same period of time should be used for estimates of both future conditions.

C. Production Data

Benefits to drainage measures from increased production are expressed as an increase in agricultural income resulting from the project less any crop production costs and on-farm capital costs associated with the increase. Therefore, estimates of future land use and yields that can be achieved "with" and "without" project conditions must be converted to terms of agricultural income.

With drainage, it is reasonable to expect a wide divergence in cropping patterns that may require considerable changes in production costs. These changes can best be measured by the use of partial or complete budget analyses.

II. BENEFITS

A. Source

Benefits to drainage measures are similar to those from changed land use and more intensive use of flood plain land. That is, benefits occur as an increased agricultural income "with" the project as compared to "without" the project. These benefits are on-site and may include the following:

1. Land Use Changes

With drainage, it may be feasible to cultivate land that has never been cultivated in the past. Wooded land may be cleared and converted to crop or pasture. Pastures or wild land may be plowed and used for crop production. In these conversions, consideration should be given to soils, topography, and the remaining elevation of the water table. Any costs involved in the clearing or preparation of the ground for the changed use should be deducted from the benefits as an associated cost. Policy limitations may limit the extent of benefits claimed from "new land" developments.

2. More Intensive Use

A second source of benefit arises from the opportunity to use

land more intensively. For example, better yields on land in its present use may be achieved as a result of reduced wetness and the opportunity to profit from better rotations and increased use of fertilizer. In addition, the quality of the product may be improved.

3. Reduced Production Costs

Another common source of benefit is through reduction in the cost of tillage operations. Better soil conditions may permit the use of a smaller tractor or reduce the time required to cover an acre. Chances of machinery getting stuck are lessened. The necessity for replanting may be eliminated.

4. Improved Resource Allocation

Benefit may also arise from a re-allocation of the resources used in production. Farmers previously with "wet" and "non-wet" areas in their units may now find it profitable to shift crops between the areas. With the new resource base afforded by the project, changes may be made in types of farming. To measure the effects of these changes on the agricultural income of the area it may be necessary to budget the "before" and "after" conditions on lands outside of the problem area or develop an overall farm or ranch analysis which will incorporate these effects.

B. Evaluation

1. Agricultural income with and without project conditions

From the basic data collected on future land use and yields and on production costs, budgets should be developed to determine the agricultural income "with" and "without" the project. Circumstances that exist in and surrounding the problem area will dictate the method of budgetary analysis to be used. These may include the following analyses: (1) individual crop budgets for the problem area and other lands associated therewith; or (2) an overall farm analysis. In isolated mountain basins or other areas where normal market opportunities do not prevail for the crops produced the analysis may include any associated livestock enterprise.

The increased agricultural income with the project less any associated costs (on-farm capital expenditures or other costs) not covered in the budgetary analysis is a benefit to the drainage measures.

2. Allowance for Lag in Accrual

As with all other types of enhancement benefits, benefits should be discounted for any expected lag in accrual. In some watersheds the operators may have to install on-farm measures (ditches, clearings, etc.) in order to realize the full benefits. The operators may not be able to install all of these on-farm measures during the project installation period even though technical assistance is available. Where this is the case,

appropriate discounting of benefits to reflect the expected lag is required. Where the area to be benefited is now in agricultural production, and most of the on-farm drainage is installed, benefits will usually accrue at their full level within the first year or two after installation of needed measures. In this case, no discounting is required.

3. Division of Benefits Between Drainage and Flood Prevention

In many cases, multiple purpose channels that provide for both drainage and flood prevention will need to be evaluated. In these situations, drainage and flood prevention benefits may accrue on the same areas. The method of evaluation depends upon the type of flood prevention benefits. If the flood prevention benefits are of the enhancement type, the total evaluation can be made by the same method as indicated in this chapter.

If the flood prevention benefits are of the damage reduction type the evaluation should follow methods presented in Chapter 3 for the flood prevention benefits and the methods in this chapter for the drainage benefits.

It is generally accepted that enhancement type benefits resulting from both drainage and flood prevention measures are not identifiably separable. For project analysis an arbitrary division of 50 percent to flood prevention and 50 percent to drainage may be used to divide benefits for this purpose. Deviations from these percentages should be used where physical data indicate a more equitable division.

III. COSTS

A realistic appraisal of all costs is just as important as an adequate appraisal of benefits. Local practices in contracting, availability of contractors and needed equipment, costs of similar jobs and physical conditions which would affect costs should all be taken into consideration in preparing cost estimates.

A. Types of Cost

1. Project Costs

Project costs may include, but are not limited to the type of costs listed below.

Easements and rights-of-way
Clearing right-of-way
Relocation or rebuilding of roads, bridges, culverts and fences
Excavation of main canals, ditches and laterals
Stabilization of canals, ditches, or laterals
Motor and pumps
Legal fees
Contingencies
Installation services in field surveys design, preparation of specifications, contracting, layout and supervision.

Annual operation and maintenance

These may in various combinations make up installation costs or be a part of annual maintenance costs. General instructions as given in the Watershed Planning Handbook are to be followed.

2. Associated Costs

In general, all on-farm capital costs and farm production costs required with drainage facilities are considered as associated costs. Of these, farm production costs and the installation and maintenance cost of land treatment measures and practices that require annual re-establishment or have an economic life less than five years are included in the budgetary analyses.

Land treatment measures, or other on-farm capital expenditures with an economic life in excess of five years are normally amortized over their economic life at an interest rate available to farmers over the life of the facility. The annual equivalent of these capital costs plus their operation and maintenance costs are then deducted from the increased agricultural income with the project to derive benefits to the drainage measures.

Examples of associated costs for a drainage project that are normally included in the budget analyses are: (1) increased tillage operations, materials and supplies; (2) additional taxes; (3) re-occurring land treatment practices and/or measures; and (4) the annual operation and maintenance of these measures.

Associated costs that are on-farm capital expenditure would include; on-farm field drains, land clearing; buildings and equipment; and the annual maintenance costs of these expenditures, etc.

3. Induced Costs

All induced costs should be taken into account where necessary in preparing a benefit-cost ratio for drainage projects. In the analysis, these are handled in the same manner as are project costs. An increase in floodwater damages (usually due to more intensive cropping and higher damageable values) can be treated as an induced cost. Another example would be the damaging effects to fish and wildlife habitat and production.

B. Cost Analysis

1. Amortization Period

In comparing benefits to costs both items are placed on a comparable basis--annual benefits versus annual costs. In relating costs to an annual equivalent the total installation costs of the project or separable parts thereof are amortized at the interest rate established for project

evaluation over their expected useful economic life or a period of 100 years, whichever is less.

2. Annual Cost

The annual cost of a project includes the amortized values of the total installation cost, operation and maintenance cost, and any induced costs.

CHAPTER 7

IRRIGATION MEASURES

Irrigation measures produce benefits that consist primarily of increases in annual agricultural income resulting from the increased production of agricultural commodities. These benefits are mainly on-site and may include the following: (1) the value of increased production of agricultural commodities less any increase in variable production costs, cost of land treatment measures and other on-farm capital expenditures associated with the increased production; (2) reduced cost in the operation and maintenance of the present irrigation facilities; and, (3) other benefits, although not entirely evaluated in monetary terms, such as improved wildlife habitat, reduction in health hazard, etc.

I. BASIC DATA

To determine the physical and economic feasibility of irrigation measures, it is necessary to collect and analyze certain basic data. This data, for project analysis, must be stated in terms of what can be accomplished without a project as well as what can be accomplished with various increments of project development. Data to be analyzed are as follows:

A. Water Supply, Water Rights and Water Quality

Water supply defines the availability of water for irrigation development. It may vary by season and area, thereby requiring special attention to types of measures, selection of priority crops, and separate evaluation areas. Water supply is generally the most significant factor affecting land use and yield response in irrigation projects. Hence, an essential step in the analysis is to determine, at some specified location, the availability of water supply with and without a project.

Water rights are of two broad types-riparian and prior appropriation. Water rights are set by state law and may limit the amount of water available for project purposes.

Water quality is generally related to its pH, salinity, and sediment load, any one of which car affect crop yield.

B. Soils

Soils data for the present and proposed irrigated area should be collected and grouped in accordance with similarities in crop adaptability and irrigation characteristics.

C. Land Treatment Needs

Estimates must be made of the amounts of each kind of land treatment measures required with each increment of project development. The amounts must be based on a realistic appraisal of the capabilities of

the farm operators and their ability to finance the improvements. However, the amounts should not be less than required to meet agreed upon conservation objectives in the use of soil and water resources.

D. Consumptive Use by Crops

Crops vary in their demand for water. Consumptive use includes all transpiration and evaporation losses from lands on which there is growth of vegetation of any kind, plus evaporation from water surfaces. Factors which influence consumptive use are climate, temperature, soils, wind movement, stage of development of the plant and its foliage. Data relating to the consumptive use of crops must be known before determining future land use and crop yields.

E. On-Farm Irrigation Efficiency

Water application efficiency is defined as the ratio of the volume of water that is stored in the soil root zone and ultimately consumed (transpired or evaporated, or both) to the volume of water delivered at the farm. Several factors such as depth of soil, topography, type of crop, etc., affect on-farm irrigation efficiency. Improvements in efficiency level can be achieved through improved methods of water application and improved water management practices. Generally, higher rates of efficiency are associated with more economic production of crops. As on-farm irrigation efficiency, consumptive use of crops and water supply are inter-related, each is important in considering project effects. The present level of on-farm irrigation efficiency should be determined and estimates should be made of future levels that can be achieved with and without the project.

F. Land Use and Crop Yields

Land use and crop yields under present conditions may be determined through interviews of farm owners and operators for each of the major soil groupings. In areas presently irrigated, this data should be collected for situations where the full irrigation water requirements of the crops are met and for situations where the irrigation water requirements of the crops are met for only a portion of the cropgrowing year. This information will be the basis for projecting crop use and yields for "with" and "without" project conditions.

Data under present conditions should be collected from all reliable sources. Information may be obtained from farm records, informed local sources, county and state reports and other published data.

Estimates of future land use and crop yields in response to water supply form the basis of determining irrigation benefits. Estimates of yields must be reasonable and well documented. Sources of secondary information that may be used include surveys of past trends and published reports relating to projections. Data from areas outside the project boundary may be used if soils, climate, water supply and other production factors are

similar. Generally, it is considered that within the long run average yields by soils and available water will at least be equal to those obtained by the best farmers today. In estimating future crop yields consideration must be given to the availability of water to meet all crop demands for the growing season. When less than a full supply is provided, consideration must be given to priority crops.

Land use estimates, where less than a full water supply is provided for the area and crops under consideration, must be based on priority crops. Available water supply, peak consumptive use by months, relative net returns of crops and demands placed upon the crop are important considerations in assigning priority crops. Crops are normally considered as first, second and third priority crops. Crops of first priority would receive first consideration in the distribution of water with crops of the lowest priority receiving the remaining supply or no supply during short water supply years.

In estimating future yields under non-project conditions, assume the application of land treatment measures and adoption of technological improvements that can reasonably be expected in the absence of the project.

Estimates of future yields with the project should be based on the application of land treatment measures required with each increment of project development. Estimates should include the adoption of technological improvements that can reasonably be expected with the project.

The same period of time must be used for both future estimates.

G. Partial or Complete Budget Analysis

Benefits to irrigation measures stemming from improved production and yield of agricultural commodities are expressed as an increase in agricultural income less any increase in variable production costs or other costs associated with the increase. Therefore, estimates of agricultural income must be determined for both "with" and "without" project conditions.

Budgets may be used to estimate agricultural income for both "with" and "without" project conditions. Depending upon circumstances, the budget analysis used may vary from a simple partial analysis to a more complete enterprise analysis.

Where additional water is used to augment existing supplies and little or no change is expected in the area irrigated or in the cropping pattern, a partial crop enterprise analysis may be used. Here, any increase in agricultural income can be measured as the difference in gross crop returns with and without the project less any variable production costs associated with the increase.

Where changes are anticipated in the economic base of the agricultural producers because of the irrigation project, differences in variable production costs may be so great that an adequate accounting of these changes will require a more detailed analysis. These may include the

following: (1) individual crop budgets for the irrigated area or lands associated with the irrigated area; or (2) an overall farm or ranch analysis.

II. BENEFITS

A. Source.

Benefits to irrigation measures are similar to benefits from changed land and more intensive use of flood plain land. That is, benefits occur as a project caused increase in agricultural income. These benefits are mainly on-site and may include the following:

1. Land Use Changes

With new developments or with improvements in existing projects it may be possible to cultivate areas that have never been in cultivation before. For example, land that has always been in woods, pasture or wild land may be cleared and converted to irrigated cropland. Consideration must be given to soils, topography, accessibility to water supply, etc. Policy limitations may limit the extent of benefits claimed from "new land".

2. More Intensive Use

Another source of benefits is the more intensive use of existing croplands. With available water, irrigated crops may be substituted for dryland crops. Or, irrigated crops having a low marginal return in response to an increasing supply of water may be replaced by crops with a higher margin of return.

3. Reduced Production Costs

With the project, savings may be made in crop production costs. For example, fields may be re-arranged, allowing a more efficient use of farm equipment, some tillage operations or the number of times over of a particular operation may be reduced, and a saving in labor to irrigate may occur with improved water applications. On the other hand, costs may be incurred with the project that would not be necessary without the project. These costs, additions or subtractions, should be handled in the budget analysis.

4. Improved Allocation of Resources

A re-allocation of resources in the farming and ranching operations of the project area may occur as a result of the irrigation project. With the removal or reduction of certain risks, capital rationing may be reduced. For example, farmers may now find it profitable to invest in improvements, change their type of farming, and shift their crop pattern between the non-irrigated and irrigated area. Therefore, to measure adequately the effects of the project on the agricultural income of the area, where these types of changes are anticipated, an overall farm or ranch analysis should be made rather than an individual crop analysis. This is particularly true in areas primarily engaged in livestock production.

5. Reduced Project Operations and Maintenance Cost

Where project works of improvement augment or supplement the present irrigation facilities, the operation and maintenance cost of the present facilities may be replaced by the project's operation and maintenance cost. The accounting of this benefit can best be handled by including the full project operation and maintenance cost in the annual cost of the project and the replaced (non-project) operation and maintenance cost in the benefit analysis.

B. Agricultural Income With and Without a Project

To measure the effects of the project on the agricultural income of the area, estimates must be made of the future income levels for both "with" and "without" project conditions. To test alternatives for project formulation estimates of income with each increment of project development may be necessary.

Although other systems may be employed in measuring the response of crops from full season and part season irrigation, the following approach is recommended in determining physical results.

1. Determine the number of acres that can be provided full season irrigation and the acreage that can be irrigated only part of the season (one month, two months, etc.)

a. With the land treatment measures that can reasonably be expected to be applied in the absence of a watershed project.

b. With improvements in water conveyance facilities and delivery schedules in addition to the land treatment measures that can reasonably be expected to be achieved without a watershed project.

c. With each system of structural measures considered, together with the land treatment measures that are needed and feasible which will most nearly meet the needs of a successful irrigation project.

With the physical information from above and with the compiled data on land use and yields for full and partial water supply, levels of income should be computed for steps Bla and Blc. The difference in these two levels of income is an increase in agricultural income attributable to the structural and the associated land treatment measures of the irrigation project.

In determining income, consideration should be given to the effects that the project may have on prices received and paid. For example, with the development of a project, the area may change from an importing to an exporting area for certain crops (i.e. forage or feed crops). Also, in areas producing more pasture and feed with the project, the demand for livestock to utilize this feed may become so keen that the farmers would bid their margin of profit away.

C. Evaluation of Benefits to the Irrigation Measures

Benefits to the irrigation measures are equal to the increase in agricultural income attributable to the structural and associated land treatment measures of the project less any associated costs (on-farm capital expenditures) not included as a variable production cost in the budget analyses.

1. <u>Allowance for Lag in Accrual</u>

Full project benefits may not be instantaneous with project installation. This is particularly true for projects requiring considerable change in the level of farm management. When this situation exists, benefits should be discounted for the expected lag in accrual.

III. COSTS

A. Type of Costs

1. <u>Project Costs</u>

These costs include the value of goods and services used for the establishment, maintenance and operation of the project including allowances for induced adverse effects.

Examples of project costs common to irrigation developments are:

Water Measuring Devices
Canal Lining
Procurement of Water Rights
Turn-Out-Structures
Main and Lateral Canals, etc.

2. <u>Associated Costs</u>

Other costs not directly concerned with project installation but incurred in order to make available the products of the project or facility are called associated costs. In general, all on-farm capital costs and farm production costs required with irrigation projects are considered as associated costs.

Farm production costs and the installation and maintenance cost of land treatment measures and practices that require annual reestablishment or have an economic life less than five years are reduced to an average annual cost and included in the budget analysis.

Land treatment measures or other on-farm capital expenditures with an economic life in excess of five years are normally amortized over their economic life at an interest rate available to farmers over the life of the facility. The annual equivalent of these capital costs plus their operation and maintenance costs are then deducted from the increased

agricultural income with the project to derive benefits to the irrigation structural measures.

Examples of associated costs that are included in the budget analysis are: (1) labor to irrigate; (2) increased tillage operations, materials and supplies; (3) additional taxes; (4) establishment of perennial crops; (5) land smoothing, on-farm ditch maintenance, stubble mulching, etc.; and (6) the annual operation and maintenance of these measures.

Examples of on-farm capital expenditures are: (1) land leveling, drainage ditches, on-farm irrigation structures, sprinkler systems; (2) buildings and equipment; and (3) the annual operation and maintenance of these measures.

3. Induced Costs

These costs include all adverse affects in goods and services caused by construction or operation of a project. Examples of such costs may be the need for drainage of areas made too wet for sustained agricultural production by the irrigation system.

B. Cost Analysis

1. Amortization Period

In comparing costs to benefits both items are placed on a comparable basis - annual benefits versus annual costs. In relating costs to an annual equivalent, the total installation costs of the project or separable parts thereof are amortized at the current federal interest rate over their expected useful economic life or a period of 100 years, whichever is less.

2. Annual Cost

The annual cost of a project includes the amortized values of the total installation cost, operation and maintenance cost, and any induced costs.

CHAPTER 8

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

This chapter deals with evaluation of facilities for provision of a municipal or industrial water supply as a part of a small watershed project. The first section describes briefly the responsibilities of the sponsoring organization and the Soil Conservation Service in the evaluation. The remainder of the chapter outlines the analysis needed by the Service to meet its responsibilities.

I. RESPONSIBILITIES IN EVALUATION

A. Sponsoring Organization

When a project includes provision for a municipal or industrial water supply it is necessary that the sponsors furnish an estimate of the benefits to be derived from this segment of the project.

The sponsors in most cases will obtain the services of engineers who will study the water supply needs, the alternative means of meeting these needs, considering both the yield and quality of water supply, estimate the costs, recommend the best solution of the water supply problems, and evaluate the benefits to be expected.

B. Soil Conservation Service

The Soil Conservation Service does not estimate the benefits to be obtained from inclusion of a water supply for municipal or industrial use as a project purpose. It does have the responsibility of checking the estimates made by the local organization to make sure that the estimated benefits are realistic, and to make certain of economic justification if the purpose is included in the project. Although the Service should not require the local organization to use certain evaluation procedures, it should indicate the nature of the tests that it will make to assure that the purpose is worthy of inclusion in the project.

II. ANALYSIS BY THE SERVICE

A. Data Required

1. Data Furnished by the Sponsors

The sponsoring organization is responsible for furnishing most of the data needed to make an evaluation of the feasibility of provisions for municipal and industrial water supply. In order to make such an evaluation, hydrologic and geologic as well as economic data must be furnished.

The water supply needs must be analyzed. This will require an estimate of future needs based on population and water use projections.

The adequacy of the proposed improvement to meet these needs must be determined after consideration of water yield at the site of the improvement and evaporation and seepage losses. Ordinarily a water budget through a critical period will need to be prepared for this determination.

Alternative sources of supply need to be examined to determine the cheapest alternative to the proposed project facility which will provide an equivalent water supply both in quantity and quality. The sponsoring organization will usually furnish the Service with any estimates of the costs of alternatives they may have made.

When provision of a water supply for non-agricultural purposes is included in a multiple-purpose structure, the sponsors will furnish the estimated cost of features of the structure designed specifically for the water supply. They will also provide estimates of the cost of operating and maintaining the water supply facility, including such items as filter plants, pumps, and pipe lines.

Finally, the sponsors will provide an estimate of the municipal and/or industrial water supply benefits that will accrue to the features of the project that are included for this purpose. If recreation is not a purpose of the water supply development, recreational benefits from incidental use of the facility may be claimed for economic justification where recreational use can reasonably be expected to develop. In this case, however, the cost of installing, replacing, operating and maintaining any recreational facilities should be deducted from the incidental recreational benefits. When recreation is also a purpose of the water supply development and Federal project funds are used for installation of the recreational facilities, recreation benefits should not be included with municipal and industrial water supply benefits.

2. Data Accumulated by the Service

The Soil Conservation Service will need to obtain sufficient data to enable it to fulfill its responsibility for checking estimates made by the sponsoring organization. Some of this information will be inherent in the particular facility being studied.

The water yield at the site should be determined with sufficient accuracy to provide reasonable estimates of the supply particularly during critical periods.

Accumulation of information on the water supply needs, and the costs and benefits from water supply developments in other comparable situations, will provide a convenient benchmark for Service appraisal of estimates submitted by the sponsoring organization.

B. Benefit Determination

Municipal and industrial water supply is considered to be economically justified if it supplies water at no greater cost than the cheapest most likely alternative source that would be utilized in the absence of

the project. Where an alternative source is not available or would not be economically feasible, benefits may be estimated on the basis of the average cost of raw water from water supply projects planned or recently constructed in the general area or region. This is not quite the same as if water is considered to be worth what it costs insofar as a given community is concerned. When the cost becomes too high, further development is handicapped. At some point the cost may become so excessive that migration to an area where costs are lower will take place. This is especially true in the case of water for industrial use. Information on costs of water in similar situations elsewhere is helpful in estimating the upper limit of justifiable water costs.

The sponsoring organization's estimate of benefits from the provision of a water supply may include only the benefits from the multiple-purpose development. On the other hand, it may cover the benefits from the entire water supply system, including facilities for storage, purification and distribution. In all cases the Service must ascertain just what is included before it can judge the validity of the estimate. When other than project facilities are included, the cost of providing, operating and maintaining the additional features may be converted to an annual figure and deducted from the water supply benefits as an associated cost.

In areas designated under the Area Redevelopment Act, or under similar circumstances where redevelopment benefits may be claimed, the Service should ascertain if the benefit claimed for water supply development includes additional employment of otherwise underemployed local labor through industrial expansion. When this is the case, if the non-agricultural water management benefits are not adjusted there will be double counting of benefits if redevelopment benefits from this source are claimed.

The possibility of double counting will be avoided if secondary benefits are not claimed in those cases where provision of a municipal or industrial water supply leads to the establishment of an industry for which redevelopment benefits are claimed.

C. Deferred Use of a Municipal or Industrial Water Supply

A watershed project may provide for construction of facilities to meet an anticipated future need of water for municipal or industrial use with repayment deferred until use of the water begins. Here costs are incurred during project installation but water supply benefits will be deferred. Consequently, benefits should be discounted for their lag in accrual. However, if the cheapest justifiable alternative source of supply is used as a measure of benefits, consideration should be given to the cost of the alternative at the time water is needed. Inasmuch as suitable reservoir sites are limited, failure to include the water supply at the time of project installation may require exceedingly heavy expenditures at the time of need.

D. Essentials for Justification of Inclusion of Municipal or Industrial Water Supply in a Project.

Industrial Water Supply in a Project

Two considerations are basic to justification of the inclusion of municipal or industrial water supply in a small watershed project. First, the Service must satisfy itself that the benefits claimed are reasonable and likely to be obtained. Next, the benefits must be equal or greater than the cost of the purpose.

Once the Service is satisfied on these points it is not concerned with detailed studies to determine the exact magnitude of benefits from providing a municipal or industrial water supply.

CHAPTER 9

RECREATIONAL AND FISH AND WILDLIFE DEVELOPMENT

This chapter describes the evaluation of recreational developments, both with regard to benefits and the cost of development. The first section discusses some of the basic data needed for projections of potential use. Then the evaluation of a recreational development as a project purpose is examined. The evaluation of recreational benefits incidental to other project purposes is explored. Finally the evaluation of fish and wildlife benefits is discussed.

The general background of the discussion is that the demand for outdoor water-based recreation will continue to increase.

I. COLLECTION OF BASIC DATA

The economic analysis of a recreational development in a watershed project is fraught with unusual difficulties. Whereas the demand for agricultural products is reasonably proportional to population, the effective demand for recreation is almost equally dependent upon many other factors. Thus projections of demand for recreation require projections of these factors as well as population. Although a considerable body of information is available for major reservoirs, data on recreational use of the size reservoirs that can be developed in small watersheds is scanty.

An analysis of the following factors, to the extent that data on each can be obtained, will provide a basis for making reasonable projections of expected demand.

A. Data from Similar Developments

During the last few years researchers have begun to investigate the use of recreational developments and have published a limited number of bulletins or other descriptions of their findings. These will contain valuable information, but they are likely to be studies of areas that have had considerable recreational development. Consequently they seldom are applicable directly to areas where water-based recreational developments are new.

Most states have state agencies that are associated closely with public recreational developments. These agencies will be glad to collaborate with Service personnel in planning the facilities needed and estimating the potential use of proposed recreational developments. Their help will be invaluable.

The Service also has been collecting information on the use of small reservoirs for recreation. Use of this information will be helpful in estimating recreational potentials.

From whatever source information is gathered, it can be expected that extensive modification will be needed before it can be applied to a given site or project.

B. Projections

The potential use of a recreational development depends upon a number of factors outside the site itself.

An important factor is the population in the area from which the potential users will come. The size of this area will depend upon the size of the development and the facilities associated with it, the presence of other facilities in the area, and accessibility of the development. Probably in most cases the area from which the greatest use can be expected will be limited to a radius of 50 miles or one hour's driving time, whichever is the lesser. Projections of population growth usually are available for general areas, although probably not for the specific area involved. These projections should be considered in determining the possible use of a development. However, the date when the projection was made is important. Increases in population have been so great that many of the projections made before 1950 already are obsolete.

The demand for recreation is related closely to per capita income. As disposable income increases the proportion required to meet the basic needs of mere existence declines. An increasing share is available for recreation and the other amenities of life. Projections of income also are available although usually not for as localized areas as is often the case with population projections. However, adjustments may be made for local areas by considering the relationship that income in such areas bears to the overall income of the general area for which projections are available.

Still a third factor upon which projections are needed is the increase in leisure time. As the work week is shortened, more leisure time is available. As the time needed for necessities such as eating and sleeping will not increase markedly, a greater proportion of off-work hours will be spent in recreation, cultural pursuits, hobbies and the like. Projections of the work week and leisure time probably are less reliable than those for population and income because of unknown factors in automation and other technological advances.

In addition to general projections there are sources of local information which will help in determining recreational trends. Information on some of the following items will be helpful. What has been the trend in similar areas with recreational development in sales of boats, motors and other equipment for water sports? What is the demand for fishing and hunting licenses in the area? How far are local residents traveling to participate in water-based recreation?

C. Competitive Facilities

Estimates of the potential use of proposed recreational facilities

will need to take into account the competition they will meet from other recreational facilities. The types of recreation provided by the project and competing facilities are important considerations here. Some facilities may attract visitors from a distance over a weekend or for a several-day vacation. Others, such as recreational developments in small watersheds, may have their greatest appeal to nearby residents who want to spend two or three hours. For these reasons it seems probable that major reservoirs and the facilities installed in small watersheds may not be markedly competitive.

D. Environmental Factors

Potential use of a recreational development also is geared to environmental factors. A development in a forested or scenic area is likely to have more than normal appeal. This is enhanced if it is in an area already frequented by tourists, and motels and restaurants are alredy present.

The effect of weather should be taken into account, not only in regard to its effect on type of activities but also its effect on potential days of use within a season.

Accessibility is a prime consideration. This involves not only distances from population centers or highways but the condition of access roads.

II. RECREATION AS A PROJECT PURPOSE

When recreation is a project purpose it is necessary to weigh the benefits against the costs to determine economic justification. Therefore, it is important to measure each within reasonable accuracy.

A. Types and Seasons of Recreation

The ordinary rather small recreational development that can be expected in small watersheds seldom can cater to all types of water-based recreation. Various kinds of recreation are competitive when attempted over the same body of water. An example is water skiing, swimming, and fishing. An essential early step in evaluation will be to determine the types of use for which it is best suited. This will depend upon the features of the project, the specialization in competing facilities, and the customs and habits of people in the user area. Once the principal uses have been determined, the climate will dictate the seasons of use.

B. Analysis of Use

A limitation upon the use that can be made of a recreational development is that which can be sustained without deterioration of the resources.

The potential types and extent of use of the proposed development will be analyzed in accordance with factors outlined in Section I of this

chapter. Consideration will be given to projected increases in demand for recreation over that which exists at the time of planning. If such increase will exceed the capacity for sustained use without deterioration, the capacity will be the limiting factor on the number of visitor-days used for evaluation purposes.

C. Assignment of Unit Values for Recreation

Numerous attempts have been made to measure the monetary value of recreation. These have ranged from assigning to recreation the full value of user expenditures to the development of demand curves. The first assigns a rather fictitious value in that, among other things, expenses for subsistence would have been incurred even had the recreationist remained at home. Development of demand curves for recreation would be time-consuming and impractical for recreation in a small watershed project.

Pending development of universally accepted systems of measurement, the Service has adopted interim values to apply equally to all types of recreation. These relate the value to the extent and quality of the facilities available.

The quantitative unit of measurement for recreation is the visitor-day which is defined as a visit by one person to a recreation site during a day regardless of how long he stays or the kind of recreation he may participate in.

The following guidelines should be used for making appropriate estimates of the value of a visitor-day.

1. Undeveloped Recreation Facilities - Where little, if any, basic facilities, other than access, are provided, a value of $0.50 per visitor-day may be used.

2. Partially Developed Recreational Facilities - Where limited basic facilities are provided, a value of $1.00 per visitor-day may be used. Examples of such facilities include parking areas, picnicking areas with no cooking facilities or tables, and simple fishing and swimming areas.

3. Fully Developed Recreational Facilities - When more extensive facilities are provided, such as parking areas, boating docks, fishing piers, camping, water skiing, overnight cabins, eating places, picnicking areas with tables and cooking facilities, play areas, and other provisions for a wide variety of recreational opportunities, a value of $1.50 per visitor-day may be used.

D. Determination of Benefits

Once the projected use in visitor-days has been determined together with the recreational value per visitor-day compatible with the facilities provided, the eventual annual value will be the product of visitor-days per year multiplied by the value per visitor-day. The

projected intensity of use generally will not be reached until some time after installation of the facilities. Therefore, in determining the average annual benefit creditable to recreation, it will be necessary to discount the flow of benefits for this build-up period.

E. Appraisal of Costs

When recreation is a project purpose, all of the costs of installation, replacement, and operation and maintenance allocated to recreation become project costs to be compared with recreational benefits to determine the economic justification of recreation.

1. Amortization of Installation Costs - The nature of the facilities when recreation is a purpose present some problems in the economic evaluation.

One problem in estimating annual costs arises because most of the basic recreation facilities will have a considerably shorter life than the water supply development. However, Federal funds can share only the original installation costs. Replacement funds must come from other sources. Therefore, it seems desirable that these facilities be amortized over the project life, with funds for replacement incorporated in the annual operation and maintenance allowance. By this device the sponsoring organization can schedule the user charges so that funds for replacement can be obtained.

The following example will illustrate the procedure:

1. Project life - 100 years.
2. Structure installation cost - $117,000.
3. A $10,000 cost item for basic recreation facilities is included which must be replaced after 50 years.

The Average Annual Cost is Computed As follows:

1. Amortize the initial installation cost, $117,000 X .03165 1/, or $3,703.
2. Estimated annual O & M cost for structure - $504.
3. Convert the future replacement cost to a present worth value and amortize over the project evaluation period: $10,000 X .22811 2/ = $2,281.10 X .03165 1/ = $72.20, or $72.
4. Total O & M, including replacement costs, is ($504 + $72) $576.
5. Annual equivalent costs are $3,703 + $576, or $4,279.

2. Operation and Maintenance - In addition to carrying an allowance for replacement of basic facilities, the allowance for ordinary operation and maintenance should be ample. Most of the basic facilities will need considerable maintenance to keep them in a condition that will attract

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1/ The 100-year amortization factor at 3 percent.

2/ The present value of 1, 50 years hence, at 3 percent interest.

use. Benches, tables, and buildings will need painting; access roads and parking areas cannot be neglected. The grounds cannot be allowed to become unsightly.

Operation of the facilities will require considerable expenditures. In many cases rather intensive fish management may be needed. If heavy use by swimmers is expected, the need for life guards is worthy of consideration. Attendants to preserve order and prevent vandalism may be desirable. If the facilities are fully or partially developed, the cost of utilities may become an item. In some cases it may be desirable to provide for regulation of the water level in the reservoir.

III. INCIDENTAL RECREATIONAL BENEFITS

Experience has shown that floodwater retarding structures, and reservoirs for municipal, industrial, or irrigation water supply may also provide incidental recreational benefits. Such benefits may be evaluated and counted in economic justification, provided public access or use by organized groups is assured.

A. Types of Use

The larger reservoirs for municipal, industrial or irrigation water supply may be used for nearly all types of water-based recreation. A sediment pool of a floodwater retarding structure generally will be used primarily only for two or three types of use because of the competitive nature of the different uses.

B. Determination of Use

In estimating the incidental use for recreation of structures built for other purposes, consideration must be given to limitations posed by size. The surface area of a sediment pool, for example, may be so small that water skiing will be impractical. Furthermore, sediment pool capacities will be depleted through deposition and their usefulness for recreation will decline as their water surface area and depth diminish. Consequently incidental recreation benefits should be calculated on a decreasing annuity after the efficiency of the pool begins to decline. Such benefits will usually cease before the sediment storage capacity is fully depleted.

Another limitation on the use of storage provided for other purposes in meeting recreational needs may be imposed by the primary purpose or the owners. For example, when municipal use is the purpose, health officials are likely to restrict recreational use both as to type of use and the area on which recreational use is permitted. Owners of farmland may prohibit hunting because of hazards to livestock. Prior water rights downstream may mean that sediment pools must be emptied upon demand. Other restrictions may be imposed depending upon the situation.

The incidental use for recreation of structures built for other purposes often will be limited by their accessibility. Even though public

use is permitted, access roads probably will be inferior to those built for access to structures designed for recreation. Such roads likely will not be all-weather roads and their maintenance may be inadequate to support heavy traffic.

All of these factors should be considered in determining the annual use in visitor-day that can reasonably be expected. In no case should the sustained use limits as determined under Section II B be exceeded, even before the utility of the structure for recreation begins to decline.

C. Assignment of Unit Values

The value assigned per visitor-day of use should be related to the recreational facilities provided. The gross value used may be approximately the same as the values suggested in Section II C.

These values cannot be used as an incidental recreational benefit without adjustment. When recreation is a project purpose, the costs of providing recreational facilities are a project cost. Unless recreation is a purpose, there are no project costs assigned to recreation. In the case of incidental recreation, costs will be incurred in providing recreation. These are considered associated costs. Some examples are:

1. The cost of providing, maintaining and replacing basic facilities. As a minimum, the pools probably will be stocked with fish at an expense to the operator, the sponsoring organization, or the State.

2. Personal services required, such as, trash disposal and collection of fees.

3. Still another cost is the risk associated with the use of these structures. When the operator purchases liability insurance, the premiums will measure this cost. If he does not insure, he is carrying the risk himself and the cost would be approximately the same.

D. Determination of Benefits

The associated costs are deducted from the gross value of a visitor-day to determine the net value of a visitor-day of incidental recreation. The number of visitor-days annually multiplied by the net value per visitor-day, properly discounted, constitutes the annual benefit from recreation incidental to other purposes.

IV. FISH AND WILDLIFE BENEFITS

Where measures are included for fish and wildlife enhancement and no recreational use is to be made of the facility, fish and wildlife benefits may be measured in terms of the cost of the cheapest alternative source of obtaining equivalent benefits that would most likely be utilized in the absence of the project.

CHAPTER 10

COST ALLOCATION AND COST SHARING

This chapter discusses in detail, with appropriate illustrations, procedures for cost allocation and cost sharing in connection with the development of watershed work plans. Section I of this chapter deals with cost allocation while Section II deals specifically with cost sharing.

Public Law 566, as amended, authorizes the Secretary "to make allocations of costs to the various purposes, and to show the basis of such allocations." Current Service Policy provides that "where a single work of improvement is planned to serve more than one purpose, an allocation of costs to each of the purposes shall be made and the method or basis of such allocations shall be described in watershed work plans."

It is important that one recognizes and remembers the distinction between cost allocation and cost sharing. Cost allocation pertains to works of improvement serving more than one purpose. It is the process whereby the cost of the structure is divided equitably among the purposes served, with each purpose receiving its fair share of the advantage resulting from the multiple-purpose installation. Cost sharing is the division of the cost allocated to each purpose to the financing agencies or groups involved. In P. L. 566 projects, costs of structural measures are shared between Federal and local funds.

Although either annual equivalent or capital costs can be used in allocations, it is a Service policy to use capital costs.

I. COST ALLOCATION

Procedures for cost allocation are grouped by types of structural measures. These types are: (1) multiple-purpose reservoir type structures, and (2) multiple-purpose channels.

The following describes the basic procedures involved. Ramifications that may be involved for particular purposes are not included as they are subject to policy changes. These variations are outlined in the Handbook and/or covered by Watershed Memorandums.

A. Definition of Terms and Their Use in Cost Allocation.

1. Alternate Cost

The alternate cost for each purpose is defined as the cheapest cost of achieving the same or equivalent benefits in single purpose structures that will accrue to each purpose in the multiple-purpose structure. The least costly alternative single purpose means of providing benefits equivalent to those provided by each purpose in the multiple-purpose structure should be used in cost allocation. The alternative should be real in the sense that it can be built and if built would produce equivalent benefits. It may, however, be entirely different in

physical plan.

2. Separable Cost

The separable cost for each project purpose is the difference between the cost of a multiple-purpose structure and the cost of the structure with that purpose omitted.

In calculating separable costs, each purpose should be treated as if it were the last increment of a multiple-purpose project. This calculation will show the added costs of increased size, changes in design, or other factors that would be necessary to add the purpose to the project.

3. Specific Cost

The specific cost for each project purpose consists of the cost of facilities that exclusively serve only one project purpose. Special outlet works needed for irrigation or municipal water supply, but not needed for flood prevention, is an example of this kind of facility.

All readily identifiable costs of facilities which are clearly for one purpose only should be assigned as specific costs wholly to that purpose in the allocation process. Thus care should be taken to make sure that all specific costs are properly assigned to each purpose.

4. Joint Cost

Joint cost is the difference between the cost of the multiple-purpose structure and the sum of the separable costs for each purpose. When the estimate of separable costs cannot be made or is unduly burdensome to make, joint costs may be considered to be the difference between the multiple-purpose cost and the sum of the specific costs for each purpose.

B. Reservoir-Type Structures

Acceptable cost allocation methods for reservoir-type structures are (1) Use of Facilities Method, (2) Alternative Justifiable Expenditure Method, and (3) Separable Cost-Remaining Benefits Method. Of these, the use of facilities method is the easiest to calculate and is readily understandable by non-technical people. Under current Service policy it is the preferred cost allocation method. Of the other two, the alternative justifiable expenditure method is the preferred method when the cost of making studies necessary to estimate separable costs is excessive.

1. Use of Facilities Method

The use of facilities method has the following steps:

a. Determine the capacity assigned to each purpose. Sediment capacity will be treated as flood prevention capacity when warranted

by the benefits from the alleviation of downstream sediment problems. Otherwise sediment capacity will not be considered in assigning capacity to purposes. Capacity serving more than one purpose will be divided equally among the purposes served.

b. Estimate the specific cost of each purpose.

c. Deduct all specific costs from the total installation cost of the multiple-purpose structure, to determine joint costs.

d. Distribute the joint costs to purposes in proportion to the capacity assigned to each purpose.

e. Add the specific cost to the joint cost (step 2 + Step 4) to determine the total cost allocated to each purpose.

The following is an example of this method:

A reservoir is designed to serve the following purposes: (1) Flood Prevention; (2) Irrigation, and (3) Municipal and Industrial Storage. Two-thousand acre-feet of the 3,500 acre feet for floodwater detention storage will be shared jointly with irrigation. The sediment damage reduction benefits are sufficient to offset the cost of sediment storage.

Estimated Total Installation Cost:

Construction Cost	=	$100,000
Installation Services	=	35,000
Land, Easements and Rights-of-way	=	30,000
Administration of Contracts	=	2,000
		$167,000

Storage	Capacity Acre-Ft.	CAPACITY BY PURPOSE: Flood Prevention	Municipal	Irrigation
For Sediment	500	500		
For Municipal Water	2,000		2,000	
For Flood Prevention	1,500	1,500		
Joint Storage for Flood Prevention and Irrigation	2,000	1,000		1,000
Total Storage	6,000	3,000	2,000	1,000
Percentage	100%	50%	33.3%	16.7%

ITEM	Total Cost	ALLOCATED COST Flood Prevention 50%	Municipal 33.3%	Irrigation 16.7%
Specific Costs				
Extra Municipal Outlet-Construction	$ 3,000		3,000	
Extra Municipal Outlet - Installation Services	900		900	
Extra Irrigation Outlet-Construction	2,000			$ 2,000
Extra Irrigation Outlet - Installation Services	600			600
Joint Costs	160,500	$80,250	$53,447	26,803
(Construction Cost)	(95,000)	(47,500)	(31,635)	(15,865)
(Installation Cost)	(33,500)	(16,750)	(11,156)	(5,594)
(Administration of Contracts)	(2,000)	(1,000)	(666)	(334)
(Rights-of-way)	(30,000)	(15,000)	(10,000)	(5,000)
Total Allocated Cost	$167,000	$80,250	$57,347	$29,403

2. Alternative Justifiable Expenditure Method

(Also called the Specific Costs-Remaining Benefits Method) This method differs from the Separable Costs-Remaining Benefits Method only to the extent that specific costs are used rather than separable costs. The cost allocated to each purpose is equal to the specific cost plus the allocated joint cost.

The Alternative Justifiable Expenditure Method, is illustrated by the following example:

ITEM	Flood Prevention	Municipal Water	Total
1. Benefits	$50,000	$40,000	$90,000
2. Alternate Costs	35,000	40,000	75,000
3. Lesser of 1 & 2	35,000	40,000	75,000
4. Specific Costs	1,000	6,000	7,000
5. Remaining Benefits	34,000	34,000	68,000
6. Allocated Joint Costs	25,500	25,500	51,000
7. Total Allocated Costs	26,500	31,500	$58,000

3. Separable Costs - Remaining Benefits Method

The Separable Costs - Remaining Benefits Method provides for

(1) assigning to each purpose its separable cost, i.e., the added cost of including the purpose in the project; and (2) assigning to each purpose a share of the remaining or residual joint cost in proportion to the remaining benefits, i.e., the benefits (as limited by alternative cost) less the separable cost). Thus the method provides for an equitable sharing of the savings from multiple-purpose development among the various purposes included.

It should be noted that the separable costs-remaining benefits method will allocate costs to purposes so that each purpose is economically justified provided that two requirements or project formulation are met:

(a) The overall benefit-cost ratio is favorable.
(b) The cost of adding each purpose as the last increment (separable cost) does not exceed the benefits derived therefrom.

The Separable-Costs-Remaining Benefits Method normally involves the following steps:

(a) Estimate the total installation cost of the multiple purpose structure.
(b) Estimate the benefits for each purpose.
(c) Estimate the alternate cost of achieving the benefits shown in step (b).
(d) Determine the maximum alternative justifiable expenditure for achieving benefits which is equal to the lesser value of steps (b) and (c).
(e) Estimate separable cost for each purpose.
(f) Determining remaining benefits which are equal to the difference between (d) and (c).
(g) Determine the joint cost which is the difference between the total cost of the multiple-purpose project and the total of the separable costs for all project purposes. The joint cost is then allocated to each purpose in the same proportion as the remaining benefits for all purposes.
(h) Determine total allocated cost for each purpose by adding the separable cost to the allocated joint cost.

The following is an example using the Separable Costs-Remaining Benefits Method:

ITEM	Flood Prevention	Municipal Water	Total
Benefits	$50,000	$40,000	$90,000
Alternate Installation Costs	35,000	40,000	75,000
Separable Installation Costs	18,000	23,000	41,000
Total Installation Costs	-------	------	$58,000

ITEM	Flood Prevention	Municipal Water	Total
1. Benefits	$50,000	$40,000 1/	$90,000
2. Alternate Costs	35,000	40,000	75,000
3. Lesser of 1 & 2	35,000	40,000	75,000
4. Separable Costs	18,000	23,000	41,000
5. Remaining Benefits	17,000	17,000	34,000
6. Allocated Joint Costs	8,500	8,500	17,000
7. Total Allocated Costs	26,500	31,500	58,000

C. Multiple-Purpose Flood Prevention and Drainage Channels

Where it is established that floodwater and drainage problems exist on the same lands within a watershed and the benefits are not separable, it will be necessary to allocate the cost of the planned channel improvement to drainage and flood prevention. Methods of allocation to fit this condition are: (1) First Alternative; (2) Second Alternative; and (3) A variation of the first two alternatives based on the percentage of the wet and non-wet land to total area served by the channel.

1. First Alternative

This method has the following steps:

a. Estimate the cost of a channel for drainage on the basis of the applicable drainage coefficient in consideration of climate, topography, land use and soils for the area of wet land needing drainage.

b. Estimate the cost of a flood prevention channel based on the capacity to handle the peak flow required to meet project objectives.

c. Design and estimate the cost of a multiple-purpose channel which will produce the same benefits as the single purpose channels in (a) and (b). This may be the same channel as the channel in (b).

d. Estimate the cost allocated to drainage by dividing the cost determined in (a) by the sum of the costs determined in (a) and (b) and multiplying by the cost determined in (c).

e. Estimate the cost allocated to flood prevention by subtracting the cost allocated to drainage determined by subtracting the cost allocated to drainage determined in (d) from the multiple-purpose cost determined in (c).

The following is an example of this method:

Drainage costs alone = $10,000

1/ Benefits estimated by the sponsoring local organization to be equal to the alternate cost of the municipal storage.

Flood Prevention costs alone = \$20,000
Cost of multiple-purpose channel = \$20,000

Step		Item
a.	\$10,000	Cost of drainage alone
b.	\$20,000	Cost of flood prevention alone
c.	\$20,000	Cost of multiple-purpose channel

d. $\frac{\$10,000}{\$30,000}$ x \$20,000 = \$6,666 drainage costs

e. \$20,000 - \$ 6,666 = \$13,334 flood prevention costs

2. Second Alternative

This procedure differs from the first alternative as benefits are used as the basis for allocating costs. This alternative is primarily applicable to flat watersheds in coastal plain or river delta type water problem areas.

a. Design and estimate the cost of the multiple-purpose channel.

b. Determine the damage reduction benefits that would accrue if the channel were designed for flood prevention alone.

c. Determine the total benefits that will accrue to the multiple-purpose channel.

d. Deduct the damage reduction benefits from total benefits, c-b, to determine the joint benefits from more intensive use of land (land enhancement).

e. Allocate the total cost of the multiple-purpose channel to land enhancement and flood damage reduction in the ratio of the benefits determined in b and d.

f. 1/ Allocate 50 percent of the joint land enhancement costs found in e to flood prevention and the remainder to drainage.

g. The total flood prevention cost is equal to the cost allocated to damage reduction plus the above percentage of the cost allocated to flood prevention from the joint land enhancement costs.

1/ Joint benefits from land enhancement may be arbitrarily split with 50 percent to flood prevention and 50 percent to drainage. However, deviations from these percentages should be used where physical data indicate a more equitable division. Costs are to be allocated on the same percentage as benefits.

The following example illustrates this alternative:

Floodwater damage reduction benefits alone	= $15,000
Total benefits for flood prevention and drainage	= $36,000
Cost of multiple-purpose channel	= $20,000
Assumed joint land enhancement benefits to flood prevention	= 50%
Assumed joint land enhancement benefits to drainage	= 50%

<u>Step</u>

a.	$20,000	= Cost of multiple-purpose channel
b.	$15,000	= Damage reduction benefits for flood prevention alone.
c.	$36,000	= Total benefits to multiple-purpose channel
d.	$36,000 = $15,000	= $21,000 (c.-b.)
e.	$\frac{15}{36}$ x $20,000	= Separable flood prevention costs of $8,333.00.
	$20,000 - $8,333	= Joint non-separable costs of $11,667.
f.	50% x $11,667 to flood prevention	= $5,834
	50% x $11,667 to drainage	= $5,833
g.	Flood Prevention	= $8,333 + $5,834 = $14,167 (e. + f.)
	Drainage	= $5,833

3. <u>Percentage of Wet and Non-Wet Land to Total Area Served.</u>

This method may be used when the joint flood prevention and drainage problem exists on the wet land in only a portion of the evaluation unit served by the multiple-purpose channel. In this procedure, the "area served", is the uncontrolled drainage area contributing to the downstream end of the multiple-purpose channel.

The non-wet area is all of the area served which is outside of the wet land to be drained, or water problem area, plus any land within the water problem area which does not have or require on-farm drainage ditches or subsurface drainage. If the upland area is not in the area

intended to benefit by drainage, it is considered non-wet.

The following steps are involved in this procedure:

a. Estimate the area served by the multiple-purpose channel. This is the total drainage area at the downstream end of the channel less the drainage area of all existing or planned control measures that contribute to this drainage.

b. Estimate the acres of wet land within the above acreage.

c. Deduct the wet land from the total area served, a.-b., to determine the acres of non-wet land.

d. Determine the percentage of wet land to total area served by dividing step b. and step a.

e. Determine the percentage of non-wet land to total area served by dividing step c. by step a.

f. Estimate the cost of the multiple-purpose channel.

g. Allocate the total cost of multiple-purpose channel to flood prevention and drainage using the percentage obtained in steps d. and e.

The following example illustrates this method:

Step			Item
a.	5,000 acres	=	Uncontrolled area served by the multiple-purpose channel.
b.	2,000 acres	=	Acres of wet land.
c.	5,000 - 2,000	=	3,000 acres of non-wet land
d.	$\frac{2,000}{5,000}$	=	40 percent wet land
e.	$\frac{3,000}{5,000}$	=	60 percent non-wet land
f.	$100,000	=	Cost of multiple-purpose channel.
g.	$100,000 x 40%	=	$40,000 allocated to drainage.
	$100,000 x 60%	=	$60,000 allocated to flood prevention.

4. <u>Allocating the Cost of a Part of a Channel System Serving A Single Purpose</u>

Steps outlined in C 1, 2 and 3 above will not necessarily

be involved for all channels included in a project planned for flood prevention and drainage. For example:

a. That portion of the channel improvement works which extends above the wet land area would be allocated to flood prevention.

b. The cost of main drainage ditches and group laterals which are not required or designed to carry outside water will be allocated to drainage.

II. COST SHARING

After costs have been allocated to purposes, by one of the previously described acceptable methods, it is then necessary to determine the costs to be borne by either "566" or "Other" Funds. Cost-sharing criteria is set by policy and varies by purposes. These criteria are subject to change from time to time; therefore, no attempt will be made here to illustrate acceptable divisions of costs. Reference should be made to the Watershed Protection Handbook and related Watershed Memorandums for detailed instructions.

CHAPTER 11

SECONDARY BENEFITS

This chapter deals with secondary benefits as they apply to project evaluation. The first part of the chapter defines and sets forth the derivation of "stemming from" and "induced by" benefits. Also included is a brief analysis of the significance of secondary benefits as they apply to larger areas of consideration than the watershed boundary. Suggested evaluation procedures are outlined in the second part of the chapter.

I. GENERAL

A. Definition

Secondary benefits are the values added over and above the immediate products or services of the project as a result of activities "stemming from" or "induced by" the project.

B. Theory of Derivation

1. Increased Production

Benefits "stemming from" the project arise from the increased production of goods (primary benefits) afforded by the project. With this increased supply of goods, new demands are placed upon the transporting, processing and marketing industries of the project area. Profits realized by these enterprises from handling these new goods are "stemming from" benefits. Take wheat for example, the net profits to a commercial trucker in hauling the wheat from the farm to a local grain elevator, to the elevator operator from his increased business, and to the transporter from shipping the wheat from the local elevator to a primary terminal elevator located outside the watershed are "stemming from" secondary benefits. Production of goods as used here need not be limited to agriculture but may include other forms of production of goods and services such as recreation, etc.

2. Added Purchases

Benefits "induced by" the project arise from increased expenditures by people of the project area. These benefits result from the supplying of additional materials and services required to make possible the increased net returns which stem from the installation of the project facilities. An example would be the increased net income of a fertilizer and seed dealer from sales of additional fertilizer and/or seed to the producers of the project area. Likewise, "induced by" secondary benefits would incur to service stations, hotels and motels, grocery stores and other establishments that supply goods and services to those enjoying recreational or fish and wildlife developments of the project. These

increased expenditures need not be limited to the primary producers. For example, the fertilizer and seed dealer may in turn purchase additional consumer items from his increased net returns, thereby setting up a multiplier effect of "induced by" benefits.

C. Zones of Influence

The significance of secondary benefits varies by zones of consideration. From a local viewpoint, secondary benefits are quite significant when the increased products are processed and marketed within the project area. This economic effect lessens as one broadens the analysis to a state or regional viewpoint and becomes almost nil from a national point of view. Under the latter analysis and under the assumption of a continuously expanding economy, it would be expected that other uses would be available for the resources required by the project and purchases made by people of the project area would bid these production goods away from the other uses in the economy. For these reasons, secondary benefits from a national viewpoint are not considered pertinent to the economic evaluation of P. L. 566 projects.

1. Limitation

In keeping with the above thought, secondary benefits to be used for project justification are limited to those project goods and services accruing within the watershed, and those accruing outside the watershed, that are readily identifiable.

II. BENEFITS

As with all other benefit analyses the base for computing secondary benefits is the "with" and "without" project approach. Secondary benefits cannot be attributed to the project unless it can be shown that there is an increase in net income in secondary activities as a result of the project as compared with conditions to be expected in the absence of the project.

The computation of secondary benefits "stemming from" or "induced by" project measures requires vigorous economic analyses. This involves the collection of such data as normal percent profit for activity, such as transportation to local market, processing or handling by the local market, wholesaler, retailer, where sold to local consumers, and shipping of unprocessed or partially processed commodities to primary wholesale markets outside the project. At the minimum, considerable time and effort would be involved in obtaining local data and computing net values by activities.

In lieu of the time and effort involved in making separate calculations by activities, it is permissible and preferable to use the following factors on an interim basis in determining secondary benefits. The values, as obtained, are net benefits and do not require any deductions of costs that may be incurred in achieving these values.

1. The value of local secondary benefits "stemming from" the project can be considered to be equal to ten (10) percent of the direct primary benefits. Indirect benefits and benefits from the reduction of erosion damages that are based on the capitalized value of loss in expected production, as outlined in Section II A of Chapter 5 of this guide, will be excluded from consideration in computing "stemming from" benefits. The capitalized value arrived at by this procedure has built into its computation the interest of secondary beneficiaries from sustained production in the problem areas.

2. The value of local secondary benefits "induced by" the project can be considered to equal ten (10) percent of the increased costs that primary producers will incur in connection with increased or sustained production. Any cash variable costs that would be sustained in areas of erosion damage (following the procedure outlined in Section II A of Chapter 5) would give rise to "induced by" benefits.

A. Application.

Direct primary benefits as used in computing "stemming from" benefits can be considered as equal to the total primary benefits of the project which may include (1) damage reduction benefits exclusive of indirect benefits and erosion damage reduction benefits computed under the procudure in Section II A of Chapter 5, (2) more intensive land use benefits, (3) changed land use benefits, (4) agricultural water management benefits, (5) recreation benefits, (6) fish and wildlife benefits, and (7) benefits from municipal and industrial water supply.

Caution should be exercised in using benefits from municipal and industrial water supply as the sponsor's estimate may already include a value for increased net returns to secondary beneficiaries.

Increased costs that primary producers might incur in connection with increased or sustained production that gives rise to "induced by" benefits normally will fall into the following categories: (1) any sustained cash variable costs from preventing permanent land damage; (2) associated costs incurred in enhancement benefits on agricultural land, including agricultural water management benefits; (3) project operation and maintenance costs that are necessary to achieve primary project benefits, i.e., basic recreational facilities; and (4) any other costs, including wages used to determine redevelopment benefits, directly associated with marketing or using project goods or services, as for example, a city water filtration plant to use project produced water supply, concession stands and/or moorages associated with recreational developments.

B. Examples

Examples of secondary benefits that may accrue from increased or sustained agricultural production are:

1. Profits of local wholesalers and retailers from handling

increased sales of project produced products consumed locally without processing.

2. Profits of all other enterprises between the place of production and the final consumer, from handling, processing and marketing increased sales of farm products used locally and the transporting, marketing and processing cost of unprocessed or partially processed products to the first normally used wholesale market outside the watershed.

3. Profits from supplying increased goods and services used in production.

Benefits from other forms of production would be similar in nature to those listed above for agricultural production.

C. Secondary losses

An analysis of the secondary effects of a project must take into account secondary losses as well as gains. For example, where projects include facilities for storing water the loss of production in pool areas may be significant. If so, these primary losses will give rise to secondary losses. These will include both "stemming from" and "induced by" effects. These should be evaluated by applying the same percent factors as used in estimating secondary benefits and the resulting losses deducted from the gains to obtain a net secondary effect.

CHAPTER 12

REDEVELOPMENT

This chapter deals with the evaluation of redevelopment benefits that may be expected from the installation and operation of a project. Projects are not designed specifically for the purpose of producing redevelopment benefits but such benefits sometimes may accrue incidentally as a by-product of the project.

I. BACKGROUND

Benefits may be claimed from project installation, operation and maintenance in areas designated under the Area Redevelopment Act of 1961. Such benefits may be derived from added employment as a result of the project and local resources used for the project under specified conditions.

A. Areas of Chronic Unemployment or Underemployment

For an area to be designated under the Act there must have been a chronic and persistent state of significant unemployment or underemployment. In most cases the lack of full employment will be most serious among the unskilled and semiskilled laborers, and rural residents with insufficient farm resources to keep them fully employed on the farm.

B. Need for Outside Assistance

When significant underemployment in an area is persistent, local financial resources become adequate to sustain only a low degree of economic activity. Few resources remain available for economic development after minimum needs are met. Consequently assistance from outside the area becomes necessary if economic activity is to reach normal levels within a reasonable time.

C. Effect of a Project

In areas of chronic underemployment, the installation of a watershed project will bring in outside resources and will provide an opportunity to use goods, services and labor from the local area.

The goods and services produced by the project will tend to stimulate local activity on a more permanent basis. Local labor may be used in producing these goods and services or in supplying the raw materials needed for processing.

II. TYPES OF REDEVELOPMENT BENEFITS AND THEIR EVALUATION

This section describes some of the types of redevelopment benefits

that may be produced by the project, the data needed and the general procedure to be used in their evaluation.

A. Project Installation

When a watershed project is installed, considerable expenditures in the local area are required for the structural measures. There may be some employment of local labor in the preliminary geological and engineering investigations but the greatest opportunity will arise during construction. The contractor usually will have his own skilled heavy equipment operators but is likely to depend heavily upon local sources for his unskilled labor.

In appraising the effect of project installation upon the local employment situation data will be needed on the types and amount of labor used and the prevailing wage rates. Basic information can be obtained from State SCS Administrative Officers, wage boards, and contractors on the usual requirements for labor, and wage rates for the types of labor used. Such information then should be fitted to the local situation.

The labor requirements will depend largely upon the types of improvements to be installed. Requirements for drag-line operation in channel improvement will differ from those in building embankment in floodwater retarding structures. Likewise the ratio of the cost of unskilled labor to total cost will not be the same for ordinary construction as when massive rock is encountered.

The local employment situation also is a factor to be considered. Redevelopment benefits are justifiably claimed only to the extent that the project provides employment to local labor that otherwise would be unemployed or underemployed.

Once the amount of unemployed or underemployed local labor that will be employed by the project and the prevailing wage rates for labor of this type have been determined, it is possible to estimate the total labor income that project installation will provide for the local community. This sum should be converted to its annual equivalent over the project life to determine redevelopment benefits from project installation.

B. Project Operation and Maintenance

Normal project operation and maintenance will provide an opportunity for continuing employment. It can be expected that maintenance will involve a greater use of labor and less of heavy equipment than will installation in relation to the total cost. Furthermore, some project facilities, such as basic facilities for recreation, may provide employment in their operation.

The sources of data for the labor employed in project operation and maintenance are much the same as those for project installation. The

main difference in data is that wage rates used should be those projected over the period being evaluated whereas the prevailing rate applies to installation.

In evaluation of redevelopment benefits from project operation and maintenance, the value of the annual wages paid to otherwise underemployed local labor for these purposes should be determined. It cannot be expected that such underemployment will persist indefinitely. Therefore, the period considered for evaluation should be terminated at not more than 20 years after project installation. It seems likely that during this 20-year period during which redevelopment benefits can be claimed, the employment situation will improve gradually. In this case the wages to be counted as redevelopment benefits would be evaluated as a decreasing annuity beginning at their full value and declining to zero at the end of the twentieth year. The sum so obtained would be converted to an annual equivalent through amortization over the life of the project.

In the case of facilities, such as basic recreational facilities, which have a useful life shorter than that of the project, replacement costs will be included with other operation and maintenance costs. If the useful life of these facilities is 20 years or more, their replacement would not contribute to redevelopment benefits.

C. Employment Stemming from Use of Project Improvements

A third type of redevelopment benefit may arise from the expansion of an existing or the introduction of new industry as a result of services provided by the project. Perhaps the most common development of this type will be in connection with the provision of a municipal or industrial water supply, although it may result from other sources such as freedom from the flood hazard. Definite assurance in writing that the development will take place if the project facilities are provided is a prerequisite to evaluation of redevelopment benefits from this source. Only the benefits from added local employment are eligible for use. Employment of labor imported from elsewhere, or industries which by moving into the area create unemployment problems elsewhere, do not provide redevelopment benefits.

The statement regarding industrial expansion should indicate the number and kind of additional workers that will be employed. This number should be adjusted downward to allow for temporary plant shutdowns, and other normal breaks from full employment. Projected wage rates over the period for which redevelopment benefits are available should be used to determine the increase in annual wages.

Conversion to an average annual equivalent redevelopment benefit should follow the approach used for similar benefits from project operation and maintenance. A period of not more than 20 years during which chronic underemployment can be expected should be used. It can be expected that without the industry the local employment situation would gradually improve. Therefore an annuity decreasing over the redevelopment evaluation

period should be used and converted to an annual equivalent over the project life.

D. Other Possible Redevelopment Benefits

Although redevelopment benefits can be expected with greatest certainty in the case of an existing industry with unused plant capacity, they may arise from other situations. In some cases the installation of a new plant may create employment opportunities during its construction.

Expanded or new industry may increase the demand for local products in addition to providing employment.

Although redevelopment benefits other than those stemming from increased employment ordinarily are not counted for project justification, they should be considered in the detail their significance warrants. If warranted they should be described in order to set forth the significance of the project in the local economy. When they are extremely significant, they may be set forth in monetary terms even though they are not used in project justification.

When redevelopment benefits other than increased employment are evaluated, care should be taken to avoid possible duplication of benefits from other sources. Redevelopment benefits stemming from new industry may duplicate primary or secondary benefits from providing a municipal water supply. Another possibility of duplication might arise if local agricultural products were used as raw materials for processing as a result of plant expansion. If redevelopment benefits were claimed from this source they might duplicate benefits from changed use of agricultural land.

CHAPTER 13

LAND EASEMENTS AND RIGHTS-OF-WAY

This chapter provides some general guidelines and principles for use in the economic evaluation of land, easements and rights-of-way costs.

I. RESPONSIBILITY

Under Service Policy the responsibility for estimating the value of land, easements and rights-of-way rest with the local organization. The responsibility of the Service is limited to testing the reasonableness of the estimate to assure that all economic costs of land, whether purchased or donated, are included in the project cost. Where Recreational or Fish and Wildlife Developments are included as a project purpose and the Federal Government is expected to cost share in the value of land rights the Service has the additional responsibility of assuring a sound use of public funds. Since the cost of land, easements and rights-of-way are paid partially or wholly from local funds, considerable reliance should be placed on the local appraisal. The local sponsors as compared to the Service are in a better position to reflect the local market values and to judge damages caused by severance, particularly those aesthetic values which are more difficult to appraise.

II. LAND RIGHTS

A. Fee Title

Fee title is an absolute ownership of property. Land rights, which may be conveyed to the local sponsoring organization by fee title are often difficult to evaluate on a fair market base because of the change in demand and supply of land for sale in project areas, varying land use, their effect on surrounding land, and many other variables. Legally, it has been determined by Federal and State laws that no private property may be taken for public purpose without the payment of just compensation. The courts have held that just compensation means the fair market value of the property rights taken, plus damages, if any, to the remaining property. The courts have also said that the landowner should be in the "same pecuniary position" before and after the taking.

Land obtained in fee title for public purposes may be secured either by negotiation or condemnation proceedings.

1. <u>Method of Acquisition</u>.

a. Negotiation

Land may be secured through private negotiation between the sponsors and the land owner. Such proceedings are normally on the base of a willing buyer and unwilling seller. However, a price may be set by negotiation that is satisfactory to the seller, or at least he may

assume that he will be better off than what he would be if he went through court action.

b. Condemnation Proceedings

The right of eminent domain is the power belonging to the Government to take private property for public use without the consent of the owner. Many local organizations, when unable to obtain land rights by negotiation have the authority to institutue condemnation proceedings. Procedure for condemnation of land depends upon applicable statutues, with methods of determining values varying somewhat, from one legal jurisdiction to another. Generally, however, the determination of just compensation is finally made by a jury, though sometimes by agreement of the parties involved, or by the court itself. Through the years, court decisions have established the meaning of just compensation as being the fair market value.

2. Fair Market Value

The following are some general principles of establishment of fair market values:

a. Fair market value is defined as the amount that would be paid by a willing buyer, not compelled to buy, and accepted by a willing seller, not compelled to sell.

b. Property values tend to change with time. Values should be based on the supply and demand of land at the time the land will actually be required for project purposes.

c. Property should be evaluated as a unit without regard to ownership or encumbrances. The effects of the acquisition of part of a tract on the remainder should be considered in the evaluation.

d. Timber, other crops, and natural resources should not be evaluated separately except when ownership is severed from the land.

e. Special values to the property owner, such as sentimental value, are not considered in value determinations. Such values are special and peculiar to the owner and do not effect the market value.

f. Any enhanced value of the land resulting from project installations is not considered in value determination when an entire ownership is acquired.

g. When only a part of an ownership is acquired, value determination should include consideration of benefits accruing to the remaining land as a result of the project only to the extent that they offset severance damages. Courts usually have ruled that the created benefits are only offsetting against severance damages caused by depreciation of remaining land. Benefits created in excess of severance damages are excluded from

consideration. Severance damages may be only temporary in nature and be valid only for a reasonable period which is necessary for adjustment to take place.

B. Easements

Easements are distinguished from fee title as they do not transfer ownership. An easement is any of several rights which one may have over another's land. The following principles apply to easements:

1. Easements are fractional property rights.

2. Easements involve the transfer of something less than all of the rights inherent in absolute fee ownership.

3. The value of an easement is some amount less than the market value of the property before the easement was granted because some residual value remains even though it may be insignificant.

4. Easements rarely can be evaluated by comparison. The test of what constitutes the market value of easements does not lie in what buyers have paid for other easements, but rather in what the general buying public does in the real estate market in discounting the prices paid for real estate market in discounting the prices paid for real estate where easements of similar type have been granted.

5. Some types of easements may actually increase the value of the remaining portion of the tract on which the easement is granted.

6. In view of the limited conveyance of rights, it is possible for more than one easement to be granted on the same tract of land, provided the rights previously granted are not duplicated or interfered with.

7. An easement may cover only a fractional part of a tract of property.

8. Severance damages may be caused by the granting of an easement. A reliable test for severance damages is the "before" and "after" or "with" and "without" comparison of land value.

9. Severance damage caused by granting an easement is considered not to exist in perpetuity, but only for the life on any affected improvements, or a reasonable period of time for the owner to adjust to alternate uses.

10. When easements are acquired by condemnation, courts usually have ruled that benefits created by an easement are offsetting only against severance damages created at the same time. Any benefits created above severance damages are excluded from consideration.

III. METHODS OF ESTIMATING VALUES

Three basic approaches, or correlations thereof, may be used for evaluation of land and allowances for land improvement.

A. Market Data Approach

The market data approach is most often applied to determine fair market value of farm land. This method involves comparisons of market values of similar land at current prices. Included in use of this method are such considerations as speculative interest, land zoning regulations, special easements or tax evaluations, circumstances relating to sales, the shape, topography and size of the tract, and its accessibility in relation to farm commodity markets, roads, schools, churches, and related cultural facilites.

Qualified land appraisers, real estate agents, local loan agency officials, etc., are prime sources of assistance in estimating fair market values.

B. Capitalized Value of Net Income

Another approach is the income capitalization method. It is based on productive capacity of the land and involves an estimate of net income accruing to the land and choice of a capitalization rate. Where cash rental or leasing is common, this determination is relatively simple. The capitalized rate should be at the average interest rate for real estate mortgage loans and for land sales contracts in a fairly wide area. Caution should be exercised in placing too much emphasis on the capitalized value of land as many uncertainties such as the marginal value productivity of land in respect to future prices and costs, interest rates, etc., are involved in the computation. Normally, it is inferior to the market data approach based on local supply and demand of land.

C. Cost Approach

The cost approach is a partial analysis whereby price is determined through the computed cost of the separate components of land. When farm improvements are of such a nature that no sales or income data are available, it may be necessary for them to be evaluated separately from the land by using the "replacement cost-less depreciation" approach.

Cost estimates of non-farm improvements such as buildings, public utilities, oil or gas pipelines, highways, bridges, and railroads generally can be prepared on the basis of relocation in kind, modification or salvage costs.

Where land values are determined by potential use for urban-industrial, commercial, or residential use, additional factors must be con-

sidered. In the absence of any known sales of similar land for such purposes, any values set above those reflecting present land use would have to be based on the early likelihood of changed use, the asking price of several owners, relative location and desirability of property for such use, and the probable time when demand will result in sale at a given price discounted to present worth.

IV. LAND RIGHTS COSTS TO BE INCLUDED IN THE ECONOMIC EVALUATION

Land, easement, or rights-of-way costs should reflect costs (values) of the land rights acquired without any adjustment for offsetting benefits. Included in this cost would be the full values of the land rights based on either market values or income losses, time and travel expense associated with the acquisition of land rights, legal fees, recording fees, and other incidental expenses.

Land rights to be evaluated for reservoirs should be limited to the area used by the dam, emergency spillway, storage area, borrow, and/or areas of siltation above the pool elevation under special circumstances. Where Recreational or Fish and Wildlife Development is included as one of the purposes, additional land rights will be required to assure public access and enjoyment of the development and of any associated minimum basic facilities.

Disposition of spoil, in case of channel improvement, may require easements and/or consideration of reduced production in the affected areas. Flowage easements may be needed if release rates from structures or channel improvement cause prolonged submergence or temporary high peaks which induce damage.

1. Other Economic Costs

If the income losses from the changed use of the site are greater than the annual equivalent of the estimated acquisition cost, then the difference should be charged to the project as "other economic costs." On the other hand, if the sponsor's estimate is unreasonably high considering all costs that may be required for acquisition, the effects of the estimated cost on the benefit-cost ratio and cost allocation and cost sharing, should be thoroughly explained to the sponsors. Circumstances may require an outside appraisal.

Chapter 14

SHORTCUTS IN EVALUATION PROCEDURE

The economist is faced at all times with the problem of balancing scanty data against the cost and time required to obtain and analyze more complete information. It may be necessary to adopt certain assumptions and to develop shortcut procedures in order to obtain reasonably accurate answers with minimum planning costs. When so doing, he must remember that assumptions are not necessarily facts.

This chapter describes some considerations involved in shortcuts to economic evaluations. It outlines circumstances where shortcuts are feasible and methods of checking to determine if shortcut results are valid.

I. PURPOSE OF SHORTCUT PROCEDURES

The obvious purpose of shortcut procedures is to save time and money. Stemming from this, of course, is the fact that if time or money is saved, more work can be accomplished by the expenditure of a given quantity of resources.

A less obvious outcome of shortcut procedures is that they may improve the quality of the overall evaluation. If used properly, they release time for more careful study of critical obscure points in the evaluation.

II. CONDITIONS CONDUCTIVE TO EFFECTIVE USE OF SHORTCUTS

A. Broad Knowledge of Problem

As general knowledge applicable to the problem at hand increases, the detailed information required for evaluation is reduced. Such general knowledge may come from a variety of sources.

Information usually is available from similar situations and is helpful in defining the general limits of answers to a particular problem.

In most cases there will be a variety of approaches to use in evaluation. A thorough grasp of fundamental economic principles will help the worker select the most efficient approach to solution of a given problem.

Shortcuts in economic investigations can be used most effectively if the economist has a general understanding of the data from other specialized fields and the limitations thereof.

Another prerequisite to the sound use of shortcuts is an intimate knowledge of the pertinent physical and economic features of the area in-

volved. Economic analysis is something more than the mere mathematical and statistical manipulation of figures. Unless tempered with over-all knowledge and judgment, blind reliance on mathematical calculations, no matter how complex, may lead to totally unrealistic answers.

B. Known General Outcome

The detail in economic investigations may be reduced when the general nature of the outcome is known in advance. When economic justification is certain, there is no need to prolong economic studies to determine if the ratio of benefits to costs is 3.12:1 instead of 3.0 to 1. Likewise, if failure of economic justification is assured, detailed study will be wasted.

C. Size and Complexity of the Project

As the size and complexity of projects increase, the amount of time required for economic appraisal also increases, although not necessarily in direct proportion.

When a project includes multiple-purposes, the detail required will be increased. Sufficient time is required to make certain that each project facility has the capability of meeting the needs specified. Evidence that each of the purposes included is justified must be obtained. In many cases, especially where flood prevention and drainage are involved, additional investigations are needed for cost allocation. Finally, multiple-purpose projects often involve inter-relationships among the effects of the various purposes. Careful economic analysis often will be needed to determine whether these effects tend to complement or nullify each other.

The sampling intensity may be reduced when the area encompassed by a project is relatively homogeneous. If, however, there are numerous variations in conditions, the overall sampling will need to be increased in order to be sure that significant variations have been sampled adequately. In addition, thorough analysis will be needed to be sure that the effects of one variation upon another, if any, have been uncovered.

The amount of time spent in economic investigations should be related to the cost of the project. Obviously more time can be spent profitably in determining if a $5,000,000 expenditure is justified than if only $100,000 is involved.

Another determinant of the need for investigative thoroughness is the relationship of the project with other projects. A common example of such a situation is where the project area constitutes a component part of a larger watershed area and works of improvement within the project area can be expected to affect downstream areas. Investigations need to be in sufficient detail in such cases to determine the general magnitude of downstream effects and whether they are benefits or induced costs.

III. POSSIBLE SHORTCUTS

A. Empirical Relationships

As experience is gained in watershed planning a body of data is acquired. Analysis of this information may disclose relationships that can be stated as empirical formulas or equations. In many areas a study of flood damage to crops has provided information that relates damage to depth, duration and season of flooding with applicability to wide areas. When relationships such as these are developed, much saving can be obtained in expensive field investigation to determine crop damage rates in a given watershed. Then only enough crop damage investigation needs to be made in each case to determine if adjustments in the overall rates are needed in that particular watershed.

Another relationship that may be set out in empirical form is the effect of recurring flooding on crop damage. An equation of this type developed for the Historical Series method is illustrated in Chapter 3, II, B. Such a device enables one to accomplish in a few minutes that which would require hours or days if a flood-by-flood correction were used.

Information is becoming available on the use of sediment pools of floodwater retarding structures for incidental recreation. This information, when carefully analyzed, forms a basis for estimating the use that will be made of other sediment pools under similar situations.

Other illustrations could be given. Each economist should be alert to the possibility of developing such relationships. Time spent in exploration of this type may be most productive. Once a tentative relationship is determined, however, it should be tested under various situations to determine its accuracy and how widely it may be used.

B. Analysis of Needs

A great deal of time can be saved if the economist carefully analyzes his needs for data before he starts collecting information. There is no virtue in collecting useless information; efforts should be centered on obtaining data relevant to the problem at hand. Field schedules should be limited to those necessary to obtain reliable information, for interviewing is an expensive procedure. Reliance should be placed upon simple statistical tests, such as determination of standard error of estimate, to determine if the confidence limits of the data have been narrowed sufficiently. Enough background information should be obtained to guide the economist's judgment in interpreting and analyzing the formal data he has obtained.

Careful selectivity in sources of data is necessary. Applicable secondary data may be readily available. On many technical problems, a consensus of expert judgment may be sufficient. Experts may have developed "rules of thumb" that will be adequate for a given problem.

Much time may be saved if consideration is given to the degree of accuracy required. Economic analysis depends to a large extent upon physical data developed from other disciplines. There is no merit in refining economic data to a point that it is inconsistent with the refinement of the physical data with which it is associated. In fact, refinement beyond that which is clearly necessary is not only wasteful but may mislead others to assume that its reliability is greater than is actually the case.

C. Opportunity Cost Principle

The net income foregone by using any input for a specific purpose rather than in the best alternative use is called an opportunity cost. For example, the funds invested in farm machinery and other farm investments could earn interest if placed in "E" bonds, or deposited in a bank or savings and loan association. Unpaid family labor usually could earn wages if employed elsewhere. These are opportunity costs or earnings foregone.

In some cases the principle of opportunity costs may be the only feasible means of determining values. At least, this will set limits to the possible values.

D. Analagous Situations

Consideration of analagous situations may be helpful, especially if the data does not lend itself to quantification through empirical means. It is important here to use only situations that are truly analagous.

IV. CHECKS AND BALANCES

Whether shortcuts or more detailed studies are used, there should be some system of checking on the answers obtained. Some methods are outlined briefly in this section.

A. Statistical Tests

Arithmetic means may be misleading whether they are simple or weighted averages. They may be biased easily by improper sample selection, or by extreme values. It is helpful to compare them with median and modal values. In many cases a frequency analysis may be useful.

The economist often will find it helpful to submit his data to such tests as standard deviation and standard error of estimate. These will give an indication of the central tendency and reliability.

Graphical methods of analysis should not be neglected. When the data is plotted, relationships often stand out vividly. References that are most helpful in graphic analysis are Agricultural Handbooks No. 84, June 1955; and No. 128, July 1957.

Graphical methods are very helpful in estimating trends whether mathematically fitted or free hand curves are used. When an appropriate scale is used, interpolations within the limits of known values may be made with confidence. However, extreme caution should be used when extrapolating much beyond known data.

Statistical techniques such as regression and correlation analysis and occasionally analysis of variance may be helpful in interpreting relationships.

B. Multiple Checks

An excellent test of reliability is to check results obtained by one approach against those obtained from another. This is especially true in checking shortcuts. One shortcut method may be checked against another or against the results from detailed analysis. Comparison through checking results from one detailed appraisal against another may be desirable at times.

Unless used with discretion this procedure would counterbalance the saving in time attendant upon the use of shortcuts. It is almost essential, though, in the development of shortcut procedures in determining their reliability and the limits of their applicability.

C. Reasonableness

In economic analysis the fundamental test is to determine if the results are reasonable. Experienced judgment will allow this test to be made in many cases without much mathematical investigation. It is possible, however, for even the inexperienced economist to make simple tests to determine the reasonableness of his answers. For example, does the average annual flood damage to crops exceed the net return that the farmer could expect if they were not flooded? If the damage is such that the farmer will lose money consistently, he is not likely to continue his present use of the flood plain over the long run unless such use complements the use of his other resources. When confronted with a situation of this type, the economist will re-examine his damage estimate. If these, including the estimated flood frequency and severity, are in order, he will check his estimate of land use. If no change is indicated, he will analyze background information to determine if there is a reasonable explanation of such a situation.

A similar approach is indicated in most situations where the answers appear unreasonable.

APPENDIX A - COMPOUND INTEREST AND ANNUITY TABLES

I. GENERAL

The compound interest and annuity tables at the back of this appendix are used in benefit-cost analysis when benefits are delayed for a significant period after costs are incurred, when benefits are not constant over the evaluation period, and when costs, expressed as capital or principal amounts, must be converted to an average annual cost.

Compound interest and annuity factors are functions of the interest rate and time. In the following examples and discussion it is assumed that the interest rate is 3 percent and the evaluation period is 50 years. A longer or shorter evaluation period may be used where appropriate.

II. EXPLANATION OF ANNUITY AND INTEREST FACTORS

A. Present Value of 1.

This is the amount that must be invested now at compound interest to have a value of 1 in a given length of time. The interest on $97,087 at 3 percent for one year is $2,913 and the interest plus principal at the end of one year has an accumulated value of $100,000. Thus, the present value of $100,000 one year hence is $97,087 or the present value of 1 is .97087 $\left(\frac{97,087}{100,000}\right)$. (Column 2, interest table).

B. Compound Amount of 1 (Not Shown on Table).

This is the amount that will accumulate when a given amount is invested at compound interest for a given period of time and the interest is not withdrawn. The compound amount of $1 in one year is $1.03000, in two years $1.06090, etc. It is the reciprocal of the present value of 1. Hence, to determine the compound amount of 1 in 25 years, if the appropriate factor is not known, it can be determined by dividing 1 by .47761 = 2.0938. Thus it can be said the $2.0938 in 25 years at 3 percent has a present value of 1 ($2.0938 x .47761) or the compound amount of $1 in 25 years is $2.0938.

C. Amortization

The extinguishing of a financial obligation in equal installments is called amortization. The amortization factor is the amount of the installment required to retire a debt of $1 in a given length of time. For example, if one were to borrow $1,000 at 3 percent for three years, it would be necessary to pay $353.53 per year on the note as follows:

Year	Payment	Interest Charge	Payment on Principal	Unpaid Balance
0	--	--	--	$1,000.00
1	$353.53	$30.00	$323.53	676.47
2	353.53	20.29	333.24	343.23
3	353.53	10.30	343.23	0.00
	$1,060.59	$60.59	$1,000.00	

D. Sinking Fund (Not Shown on Table)

A sinking fund is the amount accumulated for the purpose of paying a debt or for accumulating capital. It is the principal component of $1,000 in the foregoing example (as distinguished from the interest component). Hence, the sinking fund factor is equal to the amortization factor minus the interest factor (interest rate). The annuity necessary to accumulate a sinking fund of $1,000 in three years at 3 percent interest is $1,000 x .32353 (.35353 - .03000) = $323.53. Hence, the investment of $323.53 per year at 3 percent interest will have a value at the end of three years (sinking fund) of $1,000.

E. Present Value of an Annuity of $1 Per Year

The present value of $1 per year is the reciprocal of the amortization factor. It is a measure of the present value or worth of equal income amounts over a period of time. For example, an annuity of $1,000 per year for ten years is worth $8,530 at 3 percent because $8,530 invested now will yield an annual income of $1,000 for ten years ($8,530 x .11723). Since the present value of an annuity of $1 per year is the reciprocal of the amortization factor, their product must always equal 1.

F. The Amount of an Annuity of $1 Per Year

This is the amount that an investment of $1 per year will accumulate in a certain period of time at compound interest. It is the reciprocal of the sinking fund factor. The investment of $1,000 per year at 3 percent for ten years has a value at the end of ten years of $11,464. ($1,000 x 11.46388). The present value of $11,464 ten years hence is $8,530 ($11,464 x .74409). This is the same value as obtained by multiplying the annuity ($1,000) by the present value of $1 per year (8.530).

G. The Present Value of an Increasing Annuity

This is the measure of present value of an annuity that is not constant but increases uniformly over a period of time. In using this factor it is important to note that the value of $1 (which is multiplied by the factor) is the annual rate of increase and not the total increase

during the period. For example, an annuity increases uniformly over a ten-year period at which time it amounts to $1,000 per year. Hence, the annual rate of increase is $100 ($100 at the end of the first year, $200 at the end of the second year, etc.). The present value of such an annuity is $4,484 ($100 x 44.84). The increasing annuity factor is applicable only to the portion of an annuity that is increasing. For example, if there is an increase in annuity from $500 to $1,500 over 10 years, the increasing annuity would be applied only to the $100 annual increment. The original $500 would be treated as a constant annuity. The sum of the two calculations would be the total value. See problem 5.

H. The Present Value of a Decreasing Annuity

This is the reverse of an increasing annuity and is handled in the same way. It should be noted that the present value of a decreasing annuity is greater than an equal increasing annuity. The reason for this is that a decreasing annuity has a high initial value whereas an increasing annuity has a high terminal value and when reduced to present value is subject to a greater discount.

III. EVALUATION PROBLEMS INVOLVING THE USE OF ANNUITY AND INTEREST FACTORS

The following problems illustrate the use of annuity factors. Although the examples used are hypothetical, they represent the type of problems frequently encountered in economic evaluations. Discount factors that may be used to shortcut the calculations are also shown.

A. Problem 1

Floodwater damage under present flood plain conditions is estimated to be $1,000 annually. However, streambank erosion (not evaluated as a floodwater damage, see problem 2) is gradually destroying the land on which the floodwater damage occurs. Hence, the average annual floodwater damage will not be as great fifty years from now as it is at the present time. The problem is to determine how much the average annual floodwater damage should be discounted to reflect this condition. In this example it is assumed that the average annual floodwater damage fifty years hence will be $750.

Solution

The normal equivalent floodwater damage is made up of two annuities: (1) a constant annuity of $750 per year, and (2) a decreasing annuity of $250 in 50 years ($5/year).

The present value of a decreasing annuity of $5 per year for 50 years is $4,045 ($5 x 809.00787). The annual equivalent value of the decreasing annuity is $157 ($4,045 x .03887). This is added to the $750 constant annuity and the answer, $907 is the adjusted average annual floodwater damage.

Similar problems may be solved in a similar manner but the following shortcut may be helful. The rate of discounting a decreasing annuity is equal to:

$$\frac{\text{Col. 7}}{\text{n x Col. 4}}$$

For this example, the discount factor equals:

$$\frac{809.00787}{50 \times 25.72976} = .62885$$

It probably will save considerable time to calculate other factors for the most frequently used interest rates and time periods.

B. Problem 2

The streambank erosion, mentioned in problem 1, is destroying land at the rate of 5 acres per year. The reduction in net income due to this loss is $25 per acre or $125 per year. This amount ($125) is not a constant annuity but an increasing annuity; e.g., $125 the first year, $250 the second year, and $6,250 the 50th year. What is the annual equivalent streambank erosion damage?

<u>Solution</u>

1. The present value of an increasing annuity of $125 per year for 50 years is $62,901 ($125 x 503.211).

2. The annual equivalent value of $62,901 is equal to $2,445 ($62,901 x .03887) which is the average annual streambank erosion damage.

From the foregoing it is determined that the annual equivalent value of an annuity increasing at a uniform rate for 50 years is equal to the annual rate of increase x 19.560 or the value in the 50th year x .39120.

C. Problem 3

A benefit increases uniformly over a period of years and thereafter becomes constant. Determine the annual equivalent value (50 year evaluation period).

Given: The value of a benefit will amount to $3000 annually after 15 years. During the first 15 years the annuity will increase at the rate of $200 per year.

<u>Solution</u>

1. The present value of an increasing annuity of $200 per year for 15 years equals $200 x 88.938 = $17,788.

2. The present value of a constant annuity of \$3,000 for 35 years deferred 15 years equals \$3,000 x 21,487 x .64186 = \$41,375.

3. Total present value (1 + 2) = \$59,163.

4. Annual equivalent value equals \$59,163 x .03887 = \$2,300.

If the annuity increased the same as above but thereafter continued in perpetuity the annual equivalent value may be determined in the following manner: Multiply the present value of an annuity of 1 per year for the increasing period minus 1 year (in this case 14 years) add 1 and multiply by the rate of increase. For this example, the computation is: (11.29607 + 1) x \$200 = \$2,459.

D. Problem 4

A measure yields no benefit for a few years and then yields a continuing and constant benefit for the remainder of the evaluation period. What is the annual equivalent benefit?

Given: The value of forage from seeding idle bottomland to pasture is estimated at \$1,000 per year after the grass becomes established and is ready for use. It is estimated that 3 years are required for successful establishment. What is the annual equivalent benefit?

Solution

The present value of an annuity of \$1,000 per year deferred three years equals \$1,000 x .91514 = \$915.

It should be noted that in this case it is unnecessary to convert the annuity to a capital value, discount for the deferment period and reconvert to an annual equivalent value. If, however, the lag time is more than 10 years, the discounting procedure described under IV, A 2, Appendix A, should be used.

E. Problem 5

The average annual floodwater damage under present conditions is estimated to be \$1,000 annually. A study of sediment problems indicates that channel aggradation will increase this floodwater damage to \$1,500 per year in 50 years. What is the average annual damage due to channel aggradation?

Solution

The increase in damage in the 50th year is \$500. From problem 2 we know that the annual equivalent value of an increasing annuity is .39120 x the value in the 50th year (\$500) equals \$196. Hence, the average annual sediment damage is \$196. The floodwater damage is still considered to be \$1,000 per year.

F. Problem 6

Installation costs are usually expressed in lump sum capital amounts and must be converted to average annual costs for benefit-cost comparison. How this is done for some typical situations is illustrated by the following:

Given: A structure costs $10,000 and its life is at least 50 years.

Solution

On the basis of an interest rate of 3 percent, the amortization factor for 50 years is .03887. Then $10,000 x .03887 = $388.70. Hence, the annual equivalent value of the installation cost of $10,000 is $388.70.

If a shorter or longer economic life than 50 years is involved the amortization factor corresponding to the years of life should be used. For example, if the structure will last only 25 years the answer would be $10,000 x .05743 = $574.30. If 100 years, the answer is $10,000 x .03165 = $316.50.

Given: A structure costs $10,000, will last 50 years, and will be replaced at that time. The replacement will cost 50 percent more than the initial installation and will last 50 years.

Solution

First, determine the present worth of the second installation. The present value of $1 fifty years hence is .22811. Then $15,000 x .22811 = $3,422. The present value of the second installation is added to the initial cost and then amortized over 100 years as follows:

$3,422 + 10,000 = $13,422

$13,422 x .03165 = $424.81 annual equivalent cost.

The foregoing do not include all of the different kinds of problems associated with benefit and cost evaluation. They should, however, provide a basis for applying needed techniques in solving other problems.

IV. DISCOUNTING FOR LAG IN ACCRUAL OF BENEFITS

In several of the chapters of this Guide, it has been stated that any significant lag in the accrual of benefits should be appropriately discounted. Benefits expected to accrue during the installation period or soon after installation (1 or 2 years) need not be discounted. Discounting is necessary to convert one-time or annual values to equivalent annual values over the project evaluation period. Discounting for lag may be done for either a one-time value (cost or benefit), or for a series of such annual values. The two most common procedures of discounting for

lag in accrual of benefits in evaluating watershed projects are the (1) complete lag, and (2) straight-line lag. Other procedures will be necessary in instances where either (1) or (2) is not applicable.

A. The Complete Lag (with no buildup)

The following discounting procedures are recommended:

1. For a One-Time Value Occurring in the Future

This type of discounting may be done by merely multiplying the given value by the "Present Value of 1" discount factor for the appropriate years of lag. Thus, the future value is converted to a present value. The present value is converted to an annual value by amortizing it over the specific evaluation period.

For Example: If a 5-year lag is expected in a specific cost or benefit of $100, the factor .86261 ("present value of 1", 5 years hence, at 3 percent interest) is applied to determine the present value, or $86.26. To convert to an annual value over a 50-year evaluation period, using 3 percent interest, multiply the above present value by the appropriate amortization factor, or .03887 x 86.26 = $3.35.

2. For Annual Values Occurring in the Future

This type of discounting may be done in the following manner:

a. Convert the annual values to a present one-time or capital value. This is its capital value at the year when the annual values begin to accrue, which is also at the end of the lag period.

b. Discount the above present capital value for the period of lag.

c. Convert the discounted value to an annual value for the evaluation period by amortizing it over the full evaluation period.

For Example: If a 20-year lag is expected in an annual cost or benefit of $100 that will continue to accrue during the remaining 30 years of a 50-year evaluation period, determine the capital value of the 30 annual amounts by multiplying the factor for "Present Value of an Annuity of 1 per Year" for 30 years (19.60044) by the annual amount ($100), or 19.60044 x $100 = $1960.

Discount the capital value of $1,960 to present value by applying to it the 20-year discount factor of .55368 ("present value of 1", 20 years hence, at 3 percent interest), or .55368 x $1,960 = $1,085.

To convert this amount to an annual value over a 50-year evaluation period, using 3 percent interest, multiply the present value (1,085)

by the appropriate amortization factor (.03887), or .03887 x \$1085 = \$42.

An approximation of the discounted value can be determined by treating the annual values as a one-time value as in A.1 above. A sufficiently accurate result will be obtained if the lag period does not exceed 10 years in a 50-year evaluation period, or 40 years in a 100-year evaluation period. For longer periods of lag, the accuracy of the results decreases quickly to levels below 90 percent; in such cases, the method given under A.2 should be used.

B. The Straight Line Lag

This should be used where there will be a uniform build-up of benefits until a full level is reached. As an illustration, a 10-year straight line discount means that it will take 10 years at an increase of 1/10 per year to reach the full level of benefit accrual.

The following is an example of straight line discounting of annual benefits: Net returns per acre at full level = \$20. Acres to be benefited - 1,000. 500 of the 1,000 acres will have benefits accruing at full level upon installation and no discounting is required for these benefits. It is estimated that it will take 10 years for the benefits on the remaining 500 acres to reach full level and that this benefit will build up at a uniform rate over the 10 year period. The discounting may be done on either the total annual monetary benefits, or on an annual per acre benefit. If done on a per acre basis, the discounted per acre benefit must be multiplied by the number of acres involved (in this example 500) to determine the total discounted benefits. This example uses the total benefits.

500 acres x \$20 = \$10,000 annual benefit at full level.

The first step is to determine the capital value for the first 10 years:

\$10,000 ÷ 10 years = \$1,000 increase per year.

\$1,000 x 44.83899 1/ = \$44,839 capital value for first 10 years.

The second step is to determine the capital value of \$10,000 annually for the last 40 years of the 50 year evaluation period:

\$10,000 x 23.11477 2/ = \$231,148 capital value 40 years with no delay.

1/ Present value of increasing annuity for 10 years - 3%

2/ Present value of annuity of 1 per year for 40 years - 3%

$231,148 x .74409 [1] = $171,995 discounted 40 year capital value.

The third step is to amortize the total capital values obtained in steps 1 and 2 to arrive at annual equivalents:

$44,839 + $171,995 = $216,834 total capital value.

$216,834 x .03887 [2] = $8,428 discounted average annual benefit.

The fourth step is to add the full level benefits from the other 500 acres to the discounted benefits to determine total benefits.

$10,000 (full level benefits) + $8,428 (discounted benefits) = $18,428 total annual benefits on the 1,000 acres.

D. Short-cut Straight Line Method

Table A-1 provides straight line discount factors that can be used directly. To illustrate, the discounting in the above example can be done by selecting the factor for 10 years at 3 percent from the table and applying it to the full level benefits.

$10,000 x .843 = $8,430 discounted benefits.

$10,000 + $8,430 = $18,430 total benefits on the 1,000 acres.

The factors listed in table A-1 are based on a 50 & 100-year evaluation period. Similar factors for other years can be calculated by using the procedure referred to in the footnote, Table A-1.

1/ Present value of 1 ten years hence - 3%.

2/ Amortization factor 50 years - 3%.

Table A-1 - Discount factors at 3, 4, 5, and 6 percent interest rates for 50 and 100-year evaluation periods. 1/

Years of Lag	50-year Evaluation Period				100-year Evaluation Period			
	3%	4%	5%	6%	3%	4%	5%	6%
5	.927	.914	.901	.887	.940	.924	.908	.893
10	.843	.818	.793	.768	.872	.840	.809	.780
15	.766	.733	.700	.668	.810	.766	.724	.685
20	.697	.659	.621	.585	.753	.701	.652	.607
25	.634	.593	.553	.516	.702	.643	.589	.541
30	.576	.534	.494	.457	.655	.591	.534	.485
35	.524	.482	.443	.407	.612	.546	.487	.437
40	.476	.435	.398	.364	.573	.505	.446	.397
45	.432	.394	.359	.328	.537	.468	.410	.362
50	.391	.356	.324	.296	.504	.436	.379	.332

1/ These discount factors were developed by dividing discounted benefits by full level benefits. The example in item IV, B. shows, on the 500 acres being discounted, a full level annual benefit of $10,000 and a discounted annual benefit of $8,428. Thus: $8,428 ÷ $10,000 = .843 discount factor 10 years, at 3% for a 50-year evaluation period.

D. Other Ways of Discounting

In some instances lag of accrual of benefits will not be uniform over the entire build-up period. Benefits may build up rapidly immediately after installation and then taper off until full level is reached, or benefits may build very slowly for several years and then increase rapidly to full level. The following example shows a rapid initial build-up and then a tapering off of benefits to illustrate how this type of discounting is done. The following data are assumed: Annual benefits at full level = $10,000. Benefits will reach full level in 10 years. Benefits will build up at the rate of $1,600 per year for the first 5 years and $400 per year during the last 5 years. Straight line build-up is assumed during each 5 year period. During the first 5 years benefits will build up at a rate of $1,600 per year to a level of $8,000 (5 years x $1,600). During the last 5 years of the build-up period the benefits will increase by an additional $2,000 up to the full level of $10,000 at the rate of $400 per year. (5 years x $400 = $2,000).

Thus it becomes necessary to measure the capital value of 4 different rates of benefit accrual as follows:

1. The value during the 5 year build-up period at $1,600 per year.

2. The value during the next 45 years at the $8,000 level, delayed 5 years.

3. The value during the last 5 years of the build-up period at $400 per year, delayed 5 years.

4. The value of the additional $2,000 (necessary to reach full level of $10,000) over the last 40 years, delayed 10 years.

The following shows the calculation of these values:

Calculation of 1 above -

$1,600 x 13.46848 1/ = $21,550.

Calculation of 2 above -

$8,000 x 24.51871 2/ x .86261 3/ = $169,201.

Calculation of 3 above -

$400 x 13.46848 1/ x .86261 3/ = $4,647.

1/ Present value of increasing annuity for 5 years - 3%.
2/ Present value of annuity of 1 per year for 45 years - 3%.
3/ Present value of 1, 5 years hence - 3%.

Calculation of 4 above -

$2,000 x 23.11477 1/ x .74409 2/ = $34,399.

The 4 capital values as calculated above are then totaled and amortized to determine the discounted average annual benefit. This calculation is shown below:

$ 21,550	Cap. value of 5 year period increasing at $1,600 per year.
$169,201	Cap. value of $8,000 level for 45 years.
$ 4,647	Cap. value of last 5 year period increasing at $400 per year.
$ 34,399	Cap. value of $2,000 for 40 years.
$229,797	Total Cap. value during 50 year evaluation period.

$229,797 x .03887 3/ = $8,932 Discounted annual benefits.

1/ Present value of annuity of 1 per year for 40 years - 30%.

2/ Present value of 1, 10 years hence - 3%.

3/ Amortization factor 50 years - 3%.

Compound Interest and Annuity Tables - $2\frac{1}{2}$ Percent

No. of yrs. hence	Present value of 1	Amortization	Present value of an annuity of 1 per year	Amount of an annuity of 1 per year	Present value of an increasing annuity	Present value of a decreasing annuity
1	.97561	1.02500	.97561	1.00000	.97561	.97561
2	.95181	.51883	1.92742	2.02500	2.87924	2.90303
3	.92860	.35014	2.85602	3.07563	5.66504	5.75906
4	.90595	.26582	3.76197	4.15252	9.28884	9.52103
5	.88385	.21525	4.64583	5.25633	13.70811	14.16686
6	.86230	.18155	5.50813	6.38774	18.88189	19.67499
7	.84127	.15750	6.34939	7.54743	24.77075	26.02438
8	.82075	.13947	7.17014	8.73612	31.33672	33.19451
9	.80073	.12546	7.97087	9.95452	38.54328	41.16538
10	.78120	.11426	8.75206	11.20338	46.35526	49.91744
11	.76214	.10511	9.51421	12.48347	54.73885	59.43165
12	.74356	.09749	10.25776	13.79555	63.66152	69.68942
13	.72542	.09105	10.98318	15.14044	73.09199	80.67260
14	.70773	.08554	11.69091	16.51895	83.00017	92.36351
15	.69047	.08077	12.38138	17.93193	93.35715	104.74489
16	.67362	.07660	13.05500	19.38022	104.13515	117.79989
17	.65720	.07293	13.71220	20.86473	115.30747	131.51209
18	.64117	.06967	14.35336	22.38635	126.84846	145.86545
19	.62553	.06676	14.97889	23.94601	138.73348	160.84435
20	.61027	.06415	15.58916	25.54466	150.93890	176.43351
21	.59539	.06179	16.18455	27.18327	163.44201	192.61806
22	.58086	.05965	16.76541	28.86286	176.22104	209.38347
23	.56670	.05770	17.33211	30.58443	189.25507	226.71558
24	.55288	.05591	17.88499	32.34904	202.52408	244.60057
25	.53939	.05428	18.42438	34.15776	216.00885	263.02494
26	.52623	.05277	18.95061	36.01171	229.69095	281.97555
27	.51340	.05138	19.46401	37.91200	243.55274	301.43957
28	.50088	.05009	19.96489	39.85980	257.57732	321.40445
29	.48866	.04889	20.45355	41.85630	271.74850	341.85800
30	.47674	.04778	20.93029	43.90270	286.05078	362.78830
31	.46511	.04674	21.39541	46.00027	300.46934	384.18370
32	.45377	.04577	21.84918	48.15028	314.99000	406.03288
33	.44270	.04486	22.29188	50.35403	329.59919	428.32476
34	.43191	.04401	22.72379	52.61289	344.28397	451.04855
35	.42137	.04321	23.14516	54.92821	359.03196	474.19371
36	.41109	.04245	23.55625	57.30141	373.83134	497.74996
37	.40107	.04174	23.95732	59.73395	388.67082	521.70728
38	.39128	.04107	24.34860	62.22730	403.53964	546.05588
39	.38174	.04044	24.73034	64.78298	418.42756	570.78622
40	.37243	.03984	25.10278	67.40255	433.32478	595.88900
41	.36335	.03927	25.46612	70.08762	448.22200	621.35512
42	.35448	.03873	25.82061	72.83981	463.11036	647.17573
43	.34584	.03822	26.16645	75.66080	477.98144	673.34217
44	.33740	.03773	26.50385	78.55232	492.82720	699.84602
45	.32917	.03727	26.83302	81.51613	507.64005	726.67905
46	.32115	.03683	27.15417	84.55403	522.41276	753.83322
47	.31331	.03641	27.46748	87.66789	537.13847	781.30070
48	.30567	.03601	27.77315	90.85958	551.81068	809.07385

49	.29822	.03562	28.07137	94.13107	566.42326	837.14522
50	.29094	.03526	28.36231	97.48435	580.97037	865.50753
51	.28385	.03491	28.64616	100.92146	595.44652	894.15369
52	.27692	.03457	28.92308	104.44449	609.84651	923.07677
53	.27017	.03425	29.19325	108.05561	624.16546	952.27002
54	.26358	.03395	29.45683	111.75700	638.39874	981.72685
55	.25715	.03365	29.71398	115.55092	652.54202	1011.44083
56	.25088	.03337	29.96486	119.43969	666.59122	1041.40569
57	.24476	.03310	30.20962	123.42569	680.54252	1071.61530
58	.23879	.03284	30.44841	127.51133	694.39233	1102.06371
59	.23297	.03259	30.68137	131.69911	708.13730	1132.74508
60	.22728	.03235	30.90866	135.99159	721.77432	1163.65374
61	.22174	.03212	31.13040	140.39138	735.30047	1194.78414
62	.21633	.03190	31.34673	144.90116	748.71304	1226.13087
63	.21106	.03169	31.55778	149.52369	762.00953	1257.68865
64	.20591	.03148	31.76369	154.26179	775.18762	1289.45234
65	.20089	.03128	31.96458	159.11833	788.24518	1321.41692
66	.19599	.03109	32.16056	164.09629	801.18025	1353.57748
67	.19121	.03091	32.35177	169.19870	813.99104	1385.92925
68	.18654	.03073	32.53831	174.42866	826.67591	1418.46756
69	.18199	.03056	32.72030	179.78938	839.23339	1451.18786
70	.17755	.03040	32.89786	185.28411	851.66214	1484.08572
71	.17322	.03024	33.07108	190.91622	863.96097	1517.15680
72	.16900	.03008	33.24008	196.68912	876.12883	1550.39688
73	.16488	.02994	33.40495	202.60635	888.16478	1583.80183
74	.16085	.02979	33.56581	208.67151	900.06804	1617.36764
75	.15693	.02965	33.72274	214.88830	911.83790	1651.09038
76	.15310	.02952	33.87584	221.26050	923.47380	1684.96623
77	.14937	.02939	34.02521	227.79202	934.97527	1718.99144
78	.14573	.02926	34.17094	234.48682	946.34193	1753.16238
79	.14217	.02914	34.31311	241.34899	957.57354	1787.47549
80	.13870	.02903	34.45182	248.38271	968.66990	1821.92731
81	.13532	.02891	34.58714	255.59228	979.63095	1856.51445
82	.13202	.02880	34.71916	262.98209	990.45667	1891.10159
83	.12880	.02870	34.84796	270.55664	1001.14715	1926.08157
84	.12566	.02859	34.97362	278.32056	1011.70255	1961.05519
85	.12259	.02849	35.09621	286.27857	1022.12309	1996.15141
86	.11960	.02840	35.21582	294.43553	1032.40908	2031.36722
87	.11669	.02830	35.33251	302.79642	1042.56087	2066.69973
88	.11384	.02821	35.44635	311.36633	1052.57891	2102.14608
89	.11106	.02812	35.55741	320.15049	1062.46366	2137.70349
90	.10836	.02804	35.66577	329.15425	1072.21569	2173.36926
91	.10571	.02796	35.77148	338.38311	1081.83557	2209.14074
92	.10313	.02787	35.87462	347.84269	1091.32395	2245.01536
93	.10062	.02780	35.97524	357.53875	1100.68153	2280.99059
94	.09816	.02772	36.07340	367.47722	1109.90904	2317.06399
95	.09577	.02765	36.16917	377.66415	1119.00726	2353.23316
96	.09343	.02758	36.26261	388.10576	1127.97701	2389.49577
97	.09116	.02751	36.35376	398.80840	1136.81914	2425.84953
98	.08893	.02744	36.44269	409.77861	1145.53453	2462.29223
99	.08676	.02738	36.52946	421.02308	1154.12413	2498.82168
100	.08465	.02731	36.61411	432.54865	1162.58887	2535.43579
Perpetuity		.02500	40.00000		1640.00000	

Compound Interest and Annuity Tables - 3 Percent

No. of yrs. hence	Present value of 1	Amortization	Present value of an annuity of 1 per year	Amount of an annuity of 1 per year	Present value of an increasing annuity	Present value of a decreasing annuity
1	.97087	1.03000	.97087	1.00000	.97087	.97087
2	.94260	.52261	1.91347	2.03000	2.85607	2.88434
3	.91514	.35353	2.82861	3.09090	5.60149	5.71295
4	.88849	.26903	3.71710	4.18363	9.15544	9.43005
5	.86261	.21835	4.57971	5.30914	13.46848	14.00976
6	.83748	.18460	5.41719	6.46841	18.49339	19.42695
7	.81309	.16051	6.23028	7.66246	24.18503	25.65723
8	.76941	.14246	7.01969	8.89234	30.50030	32.67693
9	.76642	.12843	7.78611	10.15911	37.39805	40.46304
10	.74409	.11723	8.53020	11.46388	44.83899	48.99324
11	.72242	.10808	9.25262	12.80780	52.78563	58.24586
12	.70138	.10046	9.95400	14.19203	61.20219	68.19987
13	.68095	.09403	10.63496	15.61779	70.05455	78.83482
14	.66112	.08853	11.29607	17.08632	79.31020	90.13090
15	.64186	.08377	11.93794	18.59891	88.93813	102.06883
16	.62317	.07961	12.56110	20.15688	98.90880	114.62993
17	.60502	.07595	13.16612	21.76159	109.19408	127.79605
18	.58739	.07271	13.75351	23.41444	119.76718	141.54956
19	.57029	.06981	14.32380	25.11687	130.60262	155.87336
20	.55368	.06722	14.87747	26.87037	141.67613	170.75084
21	.53755	.06487	15.41502	28.67649	152.96467	186.16586
22	.52189	.06275	15.93692	30.53678	164.44630	202.10278
23	.50669	.06081	16.44361	32.45288	176.10021	218.54639
24	.49193	.05905	16.93554	34.42647	187.90662	235.48193
25	.47761	.05743	17.41315	36.45926	199.84676	252.89508
26	.46369	.05594	17.87684	38.55304	211.90283	270.77192
27	.45019	.05456	18.32703	40.70963	224.05793	289.09895
28	.43708	.05329	18.76441	42.93092	236.29708	307.86306
29	.42435	.05211	19.18845	45.21885	248.60212	327.05151
30	.41199	.05102	19.60044	47.57542	260.96173	346.65196
31	.39999	.05000	20.00043	50.00268	273.36133	366.65238
32	.38834	.04905	20.38877	52.50276	285.78811	387.04115
33	.37703	.04816	20.76579	55.07784	298.22998	407.80694
34	.36604	.04732	21.13184	57.73018	310.67551	428.93878
35	.35538	.04654	21.48722	60.46208	323.11393	450.42600
36	.34503	.04580	21.83225	63.27594	335.53509	472.25825
37	.33498	.04511	22.16724	66.17422	347.92946	494.42549
38	.32523	.04446	22.49246	69.15945	360.28805	516.91795
39	.31575	.04384	22.80822	72.23423	372.60244	539.72616
40	.30656	.04326	23.11477	75.40126	384.86472	562.84093
41	.29763	.04271	23.41240	78.66330	397.06746	586.25333
42	.28896	.04219	23.70136	82.02320	409.20375	609.95469
43	.28054	.04170	23.98190	85.48389	421.26710	633.93660
44	.27237	.04123	24.25427	89.04841	433.25146	658.19087
45	.26444	.04079	24.51871	92.71986	445.15119	682.70958
46	.25674	.04036	24.77545	96.50146	456.96108	707.48503
47	.24926	.03996	25.02471	100.39650	468.67624	732.50974
48	.24200	.03958	25.26671	104.40840	480.29218	757.77645

49	.23495	.03921	25.50166	108.54065	491.80474	783.27810
50	.22811	.03887	25.72976	112.79687	503.21100	809.00787
51	.22146	.03853	25.95123	117.18077	514.50472	834.95909
52	.21501	.03822	26.16624	121.69620	525.68539	861.12534
53	.20875	.03791	26.37499	126.34708	536.74915	887.50033
54	.20267	.03763	26.57766	131.13749	547.69334	914.07799
55	.19677	.03735	26.77443	136.07162	558.51554	940.85242
56	.19104	.03708	26.96546	141.15377	569.21356	967.81789
57	.18547	.03683	27.15094	146.38838	579.78546	994.96882
58	.18007	.03659	27.33101	151.78003	590.22951	1022.29982
59	.17483	.03636	27.50583	157.33343	600.54419	1049.80566
60	.16973	.03613	27.67556	163.05344	610.72817	1077.48122
61	.16479	.03592	27.84035	168.94504	620.78033	1105.32157
62	.15999	.03571	28.00034	175.01339	630.69967	1133.32192
63	.15533	.03552	28.15567	181.26379	640.48547	1161.47759
64	.15081	.03533	28.30648	187.70171	650.13703	1189.78407
65	.14641	.03515	28.45289	194.33276	659.65389	1218.23696
66	.14215	.03497	28.59504	201.16274	669.03571	1246.83200
67	.13801	.03480	28.73305	208.19762	678.28228	1275.56505
68	.13399	.03464	28.86704	215.44355	687.39353	1304.43209
69	.13009	.03449	28.99712	222.90686	696.36948	1333.42921
70	.12630	.03434	29.12342	230.59406	705.21029	1362.55263
71	.12262	.03419	29.24604	238.51189	713.91623	1391.79867
72	.11905	.03405	29.36509	246.66724	722.48764	1421.16376
73	.11558	.03392	29.48067	255.06726	730.92498	1450.64442
74	.11221	.03379	29.59288	263.71928	739.22878	1480.23731
75	.10895	.03367	29.70183	272.63086	747.39967	1509.93914
76	.10577	.03355	29.80760	281.80978	755.43835	1539.74673
77	.10269	.03343	29.81029	291.26407	763.34558	1569.65702
78	.09970	.03332	30.00999	301.00200	771.12220	1599.66701
79	.09680	.03321	30.10679	311.03206	778.76912	1629.77380
80	.09398	.03311	30.20076	321.36302	786.28729	1659.97456
81	.09124	.03301	30.29200	332.00391	793.67772	1690.26657
82	.08858	.03292	30.38059	342.96403	800.94148	1720.64715
83	.08600	.03282	30.46659	354.25295	808.07967	1751.11374
84	.08350	.03273	30.55009	365.88054	815.09346	1781.66383
85	.08107	.03265	30.63115	377.85695	821.98402	1812.29498
86	.07870	.03256	30.70986	390.19266	828.75260	1843.00483
87	.07641	.03248	30.78627	402.89844	835.40044	1873.79110
88	.07419	.03240	30.86045	415.98539	841.92884	1904.65155
89	.07203	.03233	30.93248	429.46496	848.33912	1935.58403
90	.06993	.03226	31.00241	443.34890	854.63262	1966.58644
91	.06789	.03219	31.07030	457.64937	860.81071	1997.65674
92	.06591	.03212	31.13621	472.37885	866.87476	2028.79295
93	.06399	.03205	31.20021	487.55022	872.82619	2059.99316
94	.06213	.03199	31.26234	503.17672	878.66640	2091.25549
95	.06032	.03193	31.32266	519.27203	884.39683	2122.57815
96	.05856	.03187	31.38122	535.85019	890.01892	2153.95937
97	.05686	.03181	31.43808	552.92569	895.53412	2185.39744
98	.05520	.03175	31.49328	570.51346	900.94388	2216.89072
99	.05359	.03170	31.54687	588.62887	906.24967	2248.43759
100	.05203	.03165	31.59891	607.28773	911.45295	2280.03650
Perpetuity		.03000	33.33333		1144.44444	

Compound Interest and Annuity Tables - 3¼ Percent

No. of yrs. hence	Present value of 1	Amortization	Present value of an annuity of 1 per year	Amount of an annuity of 1 per year	Present value of an increasing annuity	Present value of a decreasing annuity
1	.96852	1.03250	.96852	1.00000	.96852	.96852
2	.93804	.52450	1.90656	2.03250	2.84459	2.87508
3	.90851	.35523	2.81507	3.09856	5.57012	5.69015
4	.87991	.27064	3.69498	4.19926	9.08978	9.38514
5	.85222	.21992	4.54720	5.33574	13.35086	13.93233
6	.82539	.18613	5.37259	6.50915	18.30318	19.30492
7	.79941	.16202	6.17200	7.72069	23.89907	25.47692
8	.77425	.14396	6.94625	8.97162	30.09301	32.42317
9	.74988	.12994	7.69612	10.26319	36.84193	40.11929
10	.72627	.11873	8.42239	11.59675	44.10466	48.54169
11	.70341	.10958	9.12581	12.97364	51.84216	57.66749
12	.68127	.10197	9.80708	14.39529	60.01741	67.47457
13	.65983	.09554	10.46690	15.86313	68.59508	77.94147
14	.63906	.09004	11.10596	17.37868	77.54190	89.04743
15	.61894	.08529	11.72490	18.94349	86.82594	100.77233
16	.59946	.08114	12.32436	20.55915	96.41732	113.09668
17	.58059	.07749	12.90495	22.22733	106.28736	126.00163
18	.56231	.07425	13.46726	23.94972	116.40905	139.46889
19	.54461	.07137	14.01187	25.72808	126.75670	153.48076
20	.52747	.06878	14.53935	27.56424	137.30608	168.02011
21	.51087	.06644	15.05021	29.46008	148.03436	183.07032
22	.49479	.06433	15.54500	31.41753	158.91955	198.61532
23	.47921	.06241	16.02421	33.43860	169.94159	214.63954
24	.46413	.06065	16.48834	35.52536	181.08036	231.12779
25	.44952	.05904	16.93786	37.67993	192.31848	248.06574
26	.43537	.05756	17.37323	39.90453	203.63786	265.43898
27	.42167	.05620	17.79490	42.20143	215.02287	283.23387
28	.40839	.05494	18.20329	44.57297	226.45826	301.43716
29	.39554	.05377	18.59883	47.02160	237.92886	320.03599
30	.38309	.05268	18.98192	49.54980	249.42106	339.01791
31	.37103	.05167	19.35295	52.16017	260.92325	358.37086
32	.35935	.05073	19.71230	54.85537	272.42236	378.08315
33	.34804	.04985	20.06034	57.63817	283.90785	398.14349
34	.33708	.04903	20.39742	60.51141	295.36802	418.54091
35	.32647	.04825	20.72389	63.47803	306.79490	439.26480
36	.31620	.04753	21.04009	66.54107	318.17837	460.30489
37	.30624	.04685	21.34633	69.70365	329.50933	481.65122
38	.29660	.04620	21.64294	72.96902	340.77988	503.29416
39	.28727	.04560	21.93021	76.34052	351.98358	525.22437
40	.27823	.04503	22.20843	79.82158	363.11173	547.43280
41	.26947	.04449	22.47790	83.41578	374.16085	569.91070
42	.26099	.04398	22.73889	87.12680	385.12232	592.64959
43	.25277	.04349	22.99166	90.95842	395.99156	615.64125
44	.24481	.04304	23.23647	94.91457	406.76252	638.87772
45	.23711	.04260	23.47358	98.99929	417.43240	662.35130
46	.22965	.04219	23.70323	103.21677	427.99688	686.05453
47	.22242	.04180	23.92564	107.57131	438.44954	709.98017
48	.21542	.04142	24.14106	112.06738	448.78944	734.12123

49	.20863	.04107	24.34969	116.70957	459.01168	758.47093
50	.20207	.04073	24.55176	121.50263	469.11542	783.02269
51	.19571	.04041	24.74747	126.45147	479.09759	807.77016
52	.18955	.04010	24.93702	131.56114	488.95213	832.70717
53	.18358	.03981	25.12060	136.83688	498.63077	857.82777
54	.17780	.03953	25.29840	142.28407	508.28561	883.12617
55	.17221	.03926	25.47060	147.90831	517.75593	908.59677
56	.16678	.03900	25.63739	153.71533	527.09427	934.23416
57	.16153	.03876	25.79892	159.71107	536.30125	960.03308
58	.15645	.03853	25.95537	165.90168	545.37742	985.98846
59	.15153	.03830	26.10690	172.29349	554.31587	1012.09536
60	.14676	.03809	26.25366	178.89303	563.12332	1038.34901
61	.14214	.03788	26.39579	185.70705	571.79139	1064.74480
62	.13766	.03769	26.53346	192.74253	580.32649	1091.27826
63	.13333	.03750	26.66678	200.00666	588.72703	1117.94504
64	.12913	.03732	26.79592	207.50688	596.99055	1144.74096
65	.12507	.03715	26.92099	215.25085	605.11841	1171.66195
66	.12113	.03698	27.04212	223.24650	613.11673	1198.70406
67	.11732	.03682	27.15944	231.50202	620.97620	1225.86350
68	.11363	.03667	27.27306	240.02583	628.70170	1253.13656
69	.11005	.03652	27.38311	248.82667	636.29258	1280.51967
70	.10658	.03638	27.48969	257.91353	643.75335	1308.00936
71	.10323	.03624	27.59292	267.29572	651.08226	1335.60228
72	.09998	.03611	27.69291	276.98284	658.28303	1363.29519
73	.09683	.03598	27.78974	286.98478	665.35231	1391.08493
74	.09379	.03586	27.88352	297.31179	672.29249	1418.96845
75	.09083	.03575	27.97436	307.97442	679.10548	1446.94281
76	.08797	.03563	28.06233	318.98359	685.79267	1475.00514
77	.08520	.03553	28.14754	330.35056	692.35472	1503.15267
78	.08252	.03542	28.23006	342.08695	698.79149	1531.38273
79	.07992	.03532	28.30999	354.20477	705.10186	1559.69272
80	.07741	.03523	28.38740	366.71643	711.29275	1588.08011
81	.07497	.03513	28.46237	379.63471	717.37128	1616.54248
82	.07261	.03504	28.53498	392.97284	723.32481	1645.07746
83	.07033	.03496	28.60531	406.74446	729.15824	1673.68228
84	.06811	.03488	28.67342	420.96365	734.87633	1702.35619
85	.06597	.03480	28.73939	435.64497	740.48362	1731.09558
86	.06389	.03472	28.80329	450.80343	745.98435	1759.89887
87	.06188	.03464	28.86517	466.45455	751.36994	1788.76404
88	.05993	.03457	28.92510	482.61432	756.64237	1817.68914
89	.05805	.03450	28.98315	499.29928	761.80259	1846.67229
90	.05622	.03444	29.03937	516.52651	766.86436	1875.71166
91	.05445	.03437	29.09382	534.31362	771.81420	1904.80548
92	.05274	.03431	29.14656	552.67881	776.66477	1933.95203
93	.05108	.03425	29.19763	571.64088	781.41440	1963.14967
94	.04947	.03419	29.24710	591.21920	786.07585	1992.39677
95	.04791	.03414	29.29502	611.43383	790.61321	2021.69178
96	.04640	.03408	29.34142	632.30543	795.06950	2051.03320
97	.04494	.03403	29.38636	653.85535	799.44007	2080.41957
98	.04353	.03398	29.42989	676.10565	803.69977	2109.84946
99	.04216	.03393	29.47205	699.07909	807.87590	2139.32151
100	.04083	.03388	29.51288	722.79916	811.95914	2168.83439
Perpetuity		.03250	30.76923		977.51476	

Compound Interest and Annuity Tables - 4 Percent

No. of yrs. hence	Present value of 1	Amortization	Present value of an annuity of 1 per year	Amount of an annuity of 1 per year	Present value of an increasing annuity	Present value of a decreasing annuity
1	.96154	1.04000	.96154	1.00000	.96154	.96154
2	.92456	.53020	1.88609	2.04000	2.81065	2.84763
3	.88900	.36035	2.77509	3.12160	5.47764	5.62272
4	.85480	.27549	3.62990	4.24646	8.89686	9.25262
5	.82193	.22463	4.45182	5.41632	13.00649	13.70444
6	.79031	.19076	5.24214	6.63298	17.74838	18.94658
7	.75992	.16661	6.00205	7.89829	23.06780	24.94863
8	.73069	.14853	6.73274	9.21423	28.91333	31.68138
9	.70259	.13449	7.43533	10.58280	35.23661	39.11671
10	.67556	.12329	8.11090	12.00611	41.99225	47.22761
11	.64958	.11415	8.76048	13.48635	49.13764	55.98808
12	.62460	.10655	9.38507	15.02581	56.63280	65.37316
13	.60057	.10014	9.98565	16.62684	64.44027	75.35880
14	.57748	.09467	10.56312	18.29191	72.52492	85.92193
15	.55526	.08994	11.11839	20.02359	80.85389	97.04031
16	.53391	.08582	11.65230	21.82453	89.39642	108.69261
17	.51337	.08220	12.16567	23.69751	98.12376	120.85828
18	.49363	.07899	12.65930	25.64541	107.00907	133.51758
19	.47464	.07614	13.13394	27.67123	116.02727	146.65152
20	.45639	.07358	13.59033	29.77808	125.15501	160.24184
21	.43883	.07128	14.02916	31.96920	134.37052	174.27100
22	.42196	.06920	14.45112	34.24797	143.65353	188.72212
23	.40573	.06731	14.85684	36.61789	152.98524	203.57896
24	.39012	.06559	15.24696	39.08260	162.34816	218.82592
25	.37512	.06401	15.62208	41.64591	171.72608	234.44800
26	.36069	.06257	15.98277	44.31174	181.10399	250.43077
27	.34682	.06124	16.32959	47.08421	190.46804	266.76036
28	.33348	.06001	16.66306	49.96758	199.80541	283.42342
29	.32065	.05888	16.98371	52.96629	209.10430	300.40713
30	.30832	.05783	17.29203	56.08494	218.35386	317.69917
31	.29646	.05686	17.58849	59.32834	227.54413	335.28766
32	.28506	.05595	17.87355	62.70147	236.66599	353.16121
33	.27409	.05510	18.14765	66.20953	245.71110	371.30886
34	.26355	.05431	18.41120	69.85791	254.67187	389.72006
35	.25342	.05358	18.66461	73.65222	263.54141	408.38467
36	.24367	.05289	18.90828	77.59831	272.31348	427.29295
37	.23430	.05224	19.14258	81.70225	280.98246	446.43553
38	.22529	.05163	19.36786	85.97034	289.54331	465.80339
39	.21662	.05106	19.58448	90.40915	297.99151	485.38788
40	.20829	.05052	19.79277	95.02552	306.32307	505.18065
41	.20028	.05002	19.99305	99.82654	314.53447	525.17370
42	.19257	.04954	20.18563	104.81960	322.62261	545.35933
43	.18517	.04909	20.37079	110.01238	330.58485	565.73013
44	.17805	.04866	20.54884	115.41288	338.41888	586.27897
45	.17120	.04826	20.72004	121.02939	346.12281	606.99901
46	.16461	.04788	20.88465	126.87057	353.69505	627.88366
47	.15828	.04752	21.04294	132.94539	361.13433	648.92660
48	.15219	.04718	21.19513	139.26321	368.43968	670.12173

49	.14634	.04686	21.34147	145.83373	375.61040	691.46320
50	.14071	.04655	21.48218	152.66708	382.64603	712.94538
51	.13530	.04626	21.61749	159.77377	389.54636	734.56287
52	.13010	.04598	21.74758	167.16472	396.31139	756.31045
53	.12509	.04572	21.87267	174.85131	402.94131	778.18313
54	.12028	.04547	21.99296	182.84536	409.43653	800.17608
55	.11566	.04523	22.10861	191.15917	415.79758	822.28470
56	.11121	.04500	22.21982	199.80554	422.02518	844.50451
57	.10693	.04479	22.32675	208.79776	428.12019	866.83126
58	.10282	.04458	22.42957	218.14967	434.08360	889.26083
59	.09886	.04439	22.52843	227.87566	439.91650	911.78926
60	.09506	.04420	22.62349	237.99069	445.62012	934.41275
61	.09140	.04402	22.71489	248.51031	451.19578	957.12764
62	.08789	.04385	22.80278	259.45073	456.64488	979.93043
63	.08451	.04369	22.88729	270.82875	461.96891	1002.81772
64	.08126	.04354	22.96855	282.66190	467.16942	1025.78627
65	.07813	.04339	23.04668	294.96838	472.24805	1048.83295
66	.07513	.04325	23.12181	307.76712	477.20647	1071.95476
67	.07224	.04311	23.19405	321.07780	482.04642	1095.14881
68	.06946	.04299	23.26351	334.92091	486.76968	1118.41231
69	.06679	.04286	23.33030	349.31775	491.37807	1141.74261
70	.06422	.04275	23.39451	364.29046	495.87342	1165.13713
71	.06175	.04263	23.45626	379.86208	500.25763	1188.59339
72	.05937	.04252	23.51564	396.05656	504.53259	1212.10903
73	.05709	.04242	23.57273	412.89882	508.70022	1235.68176
74	.05490	.04232	23.62762	430.41478	512.76245	1259.30938
75	.05278	.04223	23.68041	448.63137	516.72122	1282.98979
76	.05075	.04214	23.73116	467.57662	520.57849	1306.72095
77	.04880	.04205	23.77996	487.27969	524.33621	1330.50092
78	.04692	.04197	23.82689	507.77087	527.99632	1354.32780
79	.04512	.04189	23.87201	529.08171	531.56077	1378.19981
80	.04338	.04181	23.91539	551.24498	535.03152	1402.11520
81	.04172	.04174	23.95711	574.29478	538.41049	1426.07231
82	.04011	.04167	23.99722	598.26657	541.69961	1450.06953
83	.03857	.04160	24.03579	623.19723	544.90079	1474.10532
84	.03709	.04154	24.07287	649.12512	548.01594	1498.17819
85	.03566	.04148	24.10853	676.09012	551.04694	1522.28672
86	.03429	.04142	24.14282	704.13373	553.99565	1546.42954
87	.03297	.04136	24.17579	733.29908	556.86391	1570.60533
88	.03170	.04131	24.20749	763.63104	559.65355	1594.81281
89	.03048	.04126	24.23797	795.17628	562.36639	1619.05078
90	.02931	.04121	24.26728	827.98333	565.00419	1643.31806
91	.02818	.04116	24.29546	862.10267	567.56871	1667.61352
92	.02710	.04111	24.32256	897.58677	570.06170	1691.93608
93	.02606	.04107	24.34861	934.49024	572.48486	1716.28469
94	.02505	.04103	24.37367	972.86985	574.83988	1740.65835
95	.02409	.04099	24.39776	1012.78465	577.12841	1765.05611
96	.02316	.04095	24.42092	1054.29603	579.35208	1789.47703
97	.02227	.04091	24.44319	1097.46788	581.51250	1813.92022
98	.02142	.04088	24.46461	1142.36659	583.61124	1838.38483
99	.02059	.04084	24.48520	1189.06125	585.64985	1862.87003
100	.01980	.04081	24.50500	1237.62370	587.62985	1887.37502
Perpetuity		.04000	25.00000		650.00000	

Compound Interest and Annuity Tables - 5 Percent

No. of yrs. hence	Present value of 1	Amortization	Present value of an annuity of 1 per year	Amount of an annuity of 1 per year	Present value of an increasing annuity	Present value of a decreasing annuity
1	.95238	1.05000	.95238	1.00000	.95238	.95238
2	.90703	.53780	1.85941	2.05000	2.76644	2.81179
3	.86384	.36721	2.72325	3.15250	5.35795	5.53504
4	.82270	.28201	3.54595	4.31013	8.64876	9.08099
5	.78353	.23097	4.32948	5.52563	12.56639	13.41047
6	.74622	.19702	5.07569	6.80191	17.04369	18.48616
7	.71068	.17282	5.78637	8.14201	22.01846	24.27253
8	.67684	.15472	6.46321	9.54911	27.43317	30.73574
9	.64461	.14069	7.10782	11.02656	33.23465	37.84356
10	.61391	.12950	7.72173	12.57789	39.37378	45.56529
11	.58468	.12039	8.30641	14.20679	45.80525	53.87170
12	.55684	.11283	8.86325	15.91713	52.48730	62.73495
13	.53032	.10646	9.39357	17.71298	59.38148	72.12852
14	.50507	.10102	9.89864	19.59863	66.45243	82.02716
15	.48102	.09634	10.37966	21.57856	73.66769	92.40682
16	.45811	.09227	10.83777	23.65749	80.99747	103.24459
17	.43630	.08870	11.27407	25.84037	88.41452	114.51866
18	.41552	.08555	11.68959	28.13238	95.89389	126.20825
19	.39573	.08275	12.08532	30.53900	103.41283	138.29357
20	.37689	.08024	12.46221	33.06595	110.95062	150.75578
21	.35894	.07800	12.82115	35.71925	118.48841	163.57693
22	.34185	.07597	13.16300	38.50521	126.00911	176.73993
23	.32557	.07414	13.48857	41.43048	133.49725	190.22850
24	.31007	.07247	13.79864	44.50200	140.93888	204.02714
25	.29530	.07095	14.09394	47.72800	148.32145	218.12108
26	.28124	.06956	14.37519	51.11345	155.63371	232.49626
27	.26785	.06829	14.64303	54.66913	162.86561	247.13929
28	.25509	.06712	14.89813	58.40258	170.00824	262.03742
29	.24295	.06605	15.14107	62.32271	177.05368	277.17849
30	.23138	.06505	15.37245	66.43885	183.99500	292.55094
31	.22036	.06413	15.59281	70.76079	190.82615	308.14375
32	.20987	.06328	15.80268	75.29883	197.54186	323.94643
33	.19987	.06249	16.00255	80.06377	204.13766	339.94898
34	.19035	.06176	16.19290	85.06696	210.60972	356.14188
35	.18129	.06107	16.37419	90.32031	216.95488	372.51607
36	.17266	.06043	16.54685	95.83632	223.17055	389.06292
37	.16444	.05984	16.71129	101.62814	229.25467	405.77421
38	.15661	.05928	16.86789	107.70955	235.20567	422.64210
39	.14915	.05876	17.01704	114.09502	241.02244	439.65914
40	.14205	.05828	17.15909	120.79977	246.70427	456.81823
41	.13528	.05782	17.29437	127.83976	252.25081	474.11260
42	.12884	.05739	17.42321	135.23175	257.66208	491.53581
43	.12270	.05699	17.54591	142.99334	262.93837	509.08172
44	.11686	.05662	17.66277	151.14301	268.08027	526.74449
45	.11130	.05626	17.77407	159.70016	273.08861	544.51856
46	.10600	.05593	17.88007	168.68516	277.96446	562.39863
47	.10095	.05561	17.98102	178.11942	282.70907	580.37965
48	.09614	.05532	18.07716	188.02539	287.32389	598.45681

49	.09156	.05504	18.16872	198.42666	291.81052	616.62553
50	.08720	.05478	18.25593	209.34800	296.17071	634.88145
51	.08305	.05453	18.33898	220.81540	300.40632	653.22043
52	.07910	.05429	18.41807	232.85617	304.51933	671.63850
53	.07533	.05407	18.49340	245.49897	308.51181	690.13190
54	.07174	.05386	18.56515	258.77392	312.38592	708.69704
55	.06833	.05367	18.63347	272.71262	316.14387	727.33051
56	.06507	.05348	18.69854	287.34825	319.78794	746.02905
57	.06197	.05330	18.76052	302.71566	323.32047	764.78957
58	.05902	.05314	18.81954	318.85144	326.74379	783.60911
59	.05621	.05298	18.87575	335.79402	330.06032	802.48486
60	.05354	.05283	18.92929	353.58372	333.27245	821.41415
61	.05099	.05269	18.98028	372.26290	336.38261	840.39443
62	.04856	.05255	19.02883	391.87605	339.39323	859.42326
63	.04625	.05242	19.07508	412.46985	342.30672	878.49834
64	.04404	.05230	19.11912	434.09334	345.12553	897.61746
65	.04195	.05219	19.16107	456.79801	347.85205	916.77853
66	.03995	.05208	19.20102	480.63791	350.48868	935.97955
67	.03805	.05198	19.23907	505.66981	353.03781	955.21862
68	.03623	.05188	19.27530	531.95330	355.50179	974.49392
69	.03451	.05179	19.30981	559.55096	357.88294	993.80373
70	.03287	.05170	19.34268	588.52851	360.18358	1013.14641
71	.03130	.05162	19.37398	618.95494	362.40595	1032.52039
72	.02981	.05154	19.40379	650.90268	364.55232	1051.92418
73	.02839	.05146	19.43218	684.44782	366.62486	1071.35636
74	.02704	.05139	19.45922	719.67021	368.62575	1090.81558
75	.02575	.05132	19.48497	756.65372	370.55712	1110.30055
76	.02453	.05126	19.50950	795.48640	372.42103	1129.81005
77	.02336	.05120	19.53285	836.26072	374.21955	1149.34290
78	.02225	.05114	19.55510	879.07376	375.95467	1168.89800
79	.02119	.05108	19.57628	924.02745	377.62835	1188.47428
80	.02018	.05103	19.59646	971.22882	379.24251	1208.07074
81	.01922	.05098	19.61568	1020.79026	380.79902	1227.68642
82	.01830	.05093	19.63398	1072.82978	382.29971	1247.32040
83	.01743	.05089	19.65141	1127.47126	383.74637	1266.97181
84	.01660	.05084	19.66801	1184.84483	385.14074	1286.63982
85	.01581	.05080	19.68382	1245.08707	386.48452	1306.32364
86	.01506	.05076	19.69887	1308.34142	387.77937	1326.02251
87	.01434	.05073	19.71321	1374.75849	389.02690	1345.73572
88	.01366	.05069	19.72687	1444.49642	390.22867	1365.46259
89	.01301	.05066	19.73987	1517.72124	391.38623	1385.20246
90	.01239	.05063	19.75226	1594.60730	392.50105	1404.95472
91	.01180	.05060	19.76406	1675.33767	393.57459	1424.71878
92	.01124	.05057	19.77529	1760.10455	394.60823	1444.49407
93	.01070	.05054	19.78599	1849.10978	395.60336	1464.28006
94	.01019	.05051	19.79619	1942.56527	396.56129	1484.07624
95	.00971	.05049	19.80589	2040.69353	397.48331	1503.88213
96	.00924	.05047	19.81513	2143.72821	398.37067	1523.69726
97	.00880	.05044	19.82394	2251.91462	399.22457	1543.52120
98	.00838	.05042	19.83232	2365.51035	400.04620	1563.35352
99	.00798	.05040	19.84031	2484.78586	400.83669	1583.19382
100	.00760	.05038	19.84791	2610.02516	401.59713	1603.04173
Perpetuity		.05000	20.00000		420.00000	

Compound Interest and Annuity Tables - 6 Percent

No. of yrs. hence	Present value of 1	Amortization	Present value of an annuity of 1 per year	Amount of an annuity of 1 per year	Present value of an increasing annuity	Present value of a decreasing annuity
1	.94340	1.06000	.94340	1.00000	.94340	.94340
2	.89000	.54544	1.83339	2.06000	2.72339	2.77679
3	.83962	.37411	2.67301	3.18300	5.24225	5.44980
4	.79209	.28859	3.46511	4.37462	8.41062	8.91490
5	.74726	.23740	4.21236	5.63709	12.14691	13.12726
6	.70496	.20336	4.91732	6.97532	16.37668	18.04458
7	.66506	.17914	5.58238	8.39384	21.03208	23.62696
8	.62741	.16104	6.20979	9.89747	26.05137	29.83675
9	.59190	.14702	6.80169	11.49132	31.37846	36.63844
10	.55839	.13588	7.36009	13.18079	36.96241	43.99853
11	.52679	.12679	7.88687	14.97164	42.75707	51.88540
12	.49697	.11928	8.38384	16.86994	48.72070	60.26924
13	.46884	.11296	8.85268	18.88214	54.81561	69.12192
14	.44230	.10758	9.29498	21.01507	61.00782	78.41690
15	.41727	.10296	9.71225	23.27597	67.26680	88.12915
16	.39365	.09895	10.10590	25.67253	73.56514	98.23505
17	.37136	.09544	10.47726	28.21288	79.87834	108.71231
18	.35034	.09236	10.82760	30.90565	86.18452	119.53991
19	.33051	.08962	11.15812	33.75999	92.46427	130.69803
20	.31180	.08718	11.46992	36.78559	98.70037	142.16795
21	.29416	.08500	11.76408	39.99273	104.87763	153.93203
22	.27751	.08305	12.04158	43.39229	110.98274	165.97361
23	.26180	.08128	12.30338	46.99583	117.00408	178.27699
24	.24698	.07968	12.55036	50.81558	122.93156	190.82735
25	.23300	.07823	12.78336	54.86451	128.75653	203.61071
26	.21981	.07690	13.00317	59.15638	134.47159	216.61388
27	.20737	.07570	13.21053	63.70577	140.07052	229.82441
28	.19563	.07459	13.40616	68.52811	145.54817	243.23057
29	.18456	.07358	13.59072	73.63980	150.90031	256.82129
30	.17411	.07265	13.76483	79.05817	156.12362	270.58612
31	.16425	.07179	13.92909	84.80168	161.21552	284.51520
32	.15496	.07100	14.08404	90.88978	166.17415	298.59924
33	.14619	.07027	14.23023	97.34316	170.99830	312.82947
34	.13791	.06960	14.36814	104.18375	175.68729	327.19761
35	.13011	.06897	14.49825	111.43478	180.24098	341.69586
36	.12274	.06839	14.62099	119.12087	184.65964	356.31685
37	.11579	.06786	14.73678	127.26812	188.94399	371.05363
38	.10924	.06736	14.84602	135.90421	193.09507	385.89965
39	.10306	.06689	14.94907	145.05846	197.11423	400.84872
40	.09722	.06646	15.04630	154.76197	201.00312	415.89502
41	.09172	.06606	15.13802	165.04768	204.76560	431.03304
42	.08653	.06568	15.22454	175.95054	208.39775	446.25758
43	.08163	.06533	15.30617	187.50758	211.90783	461.56375
44	.07701	.06501	15.38318	199.75803	215.29622	476.94693
45	.07265	.06470	15.45583	212.74351	218.56548	492.40276
46	.06854	.06441	15.52437	226.50812	221.71822	507.92713
47	.06466	.06415	15.58903	241.09861	224.75716	523.51616
48	.06100	.06390	15.65003	256.56453	227.68508	539.16619

49	.05755	.06366	15.70757	272.95840	230.50482	554.87376
50	.05429	.06344	15.76186	290.33590	233.21924	570.63562
51	.05122	.06324	15.81308	308.75606	235.83122	586.44870
52	.04832	.06305	15.86139	328.28142	238.34368	602.31009
53	.04558	.06287	15.90697	348.97831	240.75950	618.21706
54	.04300	.06270	15.94998	370.91701	243.08158	634.16704
55	.04057	.06254	15.99054	394.17203	245.31279	650.15758
56	.03827	.06239	16.02881	418.82235	247.45597	666.18639
57	.03610	.06225	16.06492	444.95169	249.51395	682.25131
58	.03406	.06212	16.09898	472.64879	251.48950	698.35029
59	.03213	.06199	16.13111	502.00772	253.38586	714.48140
60	.03031	.06188	16.16143	533.12818	255.20422	730.64283
61	.02860	.06177	16.19003	566.11587	256.94872	746.83286
62	.02698	.06166	16.21701	601.08282	258.62146	763.04986
63	.02545	.06157	16.24246	638.14779	260.22497	779.29232
64	.02401	.06148	16.26647	677.43666	261.76172	795.55879
65	.02265	.06139	16.28912	719.08286	263.23415	811.84791
66	.02137	.06131	16.31049	763.22783	264.64459	828.15840
67	.02016	.06123	16.33065	810.02150	265.99536	844.48905
68	.01902	.06116	16.34967	859.62279	267.28870	860.83872
69	.01794	.06110	16.36762	912.20016	268.52676	877.20634
70	.01693	.06103	16.38454	967.93217	269.71168	893.59088
71	.01597	.06097	16.40051	1027.00810	270.84549	909.99139
72	.01507	.06092	16.41558	1089.62859	271.93019	926.40697
73	.01421	.06087	16.42979	1156.00630	272.96771	942.83676
74	.01341	.06082	16.44320	1226.36668	273.95991	959.27996
75	.01265	.06077	16.45585	1300.94868	274.90859	975.73581
76	.01193	.06072	16.46778	1380.00560	275.81551	992.20359
77	.01126	.06068	16.47904	1463.80594	276.68235	1008.68263
78	.01062	.06064	16.48966	1552.63429	277.51074	1025.17229
79	.01002	.06061	16.49968	1646.79235	278.30227	1041.67197
80	.00945	.06057	16.50913	1746.59989	279.05844	1058.18110
81	.00892	.06054	16.51805	1852.39588	279.78073	1074.69915
82	.00841	.06051	16.52646	1964.53964	280.47054	1091.22561
83	.00794	.06048	16.53440	2083.41202	281.12925	1107.76001
84	.00749	.06045	16.54188	2209.41674	281.75815	1124.30189
85	.00706	.06043	16.54895	2342.98174	282.35853	1140.85084
86	.00666	.06040	16.55561	2484.56065	282.93158	1157.40645
87	.00629	.06038	16.56190	2634.63428	283.47848	1173.96835
88	.00593	.06036	16.56783	2793.71234	284.00035	1190.53618
89	.00559	.06034	16.57342	2962.33508	284.49828	1207.10960
90	.00528	.06032	16.57870	3141.07519	284.97331	1223.68830
91	.00498	.06030	16.58368	3330.53970	285.42642	1240.27198
92	.00470	.06028	16.58838	3531.37208	285.85858	1256.86036
93	.00443	.06027	16.59281	3744.25441	286.27072	1273.45317
94	.00418	.06025	16.59699	3969.90967	286.66370	1290.05016
95	.00394	.06024	16.60093	4209.10425	287.03839	1306.65109
96	.00372	.06022	16.60465	4462.65050	287.39559	1323.25574
97	.00351	.06021	16.60816	4731.40953	287.73607	1339.86390
98	.00331	.06020	16.61147	5016.29411	288.06060	1356.47537
99	.00312	.06019	16.61460	5318.27175	288.36988	1373.08997
100	.00295	.06018	16.61755	5638.36806	288.66461	1389.70752
Perpetuity		.06000	16.66667		294.44444	

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